INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

IN THIS ISSUE

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The Vickers Vanguard

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VOLUME XIV

No. 5 / 1959

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In this era that probes beyond all scientific horizons, the Convair division of General Dynamics Corporation has attained famous firsts in all four areas. **JET AGE:** B-58, first supersonic bomber. **MISSILE AGE:** Atlas, our first Intercontinental Ballistic Missile. **SPACE AGE:** The world's first ICBM to be placed in orbit. **ATOMIC AGE:** Convair was first to make tests on a nuclear reactor carried in flight.

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Volume XIV

INTERAVIA

May 1959

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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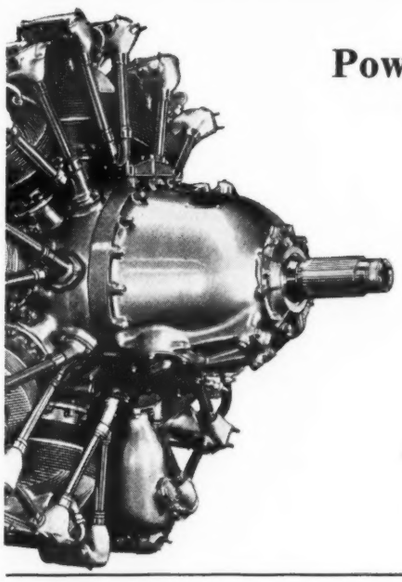
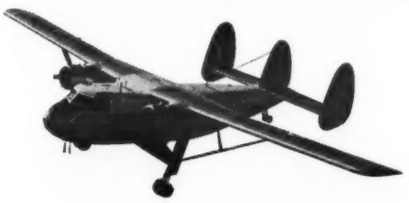
FRONT COVER : After a demonstration flight by the Douglas DC-8





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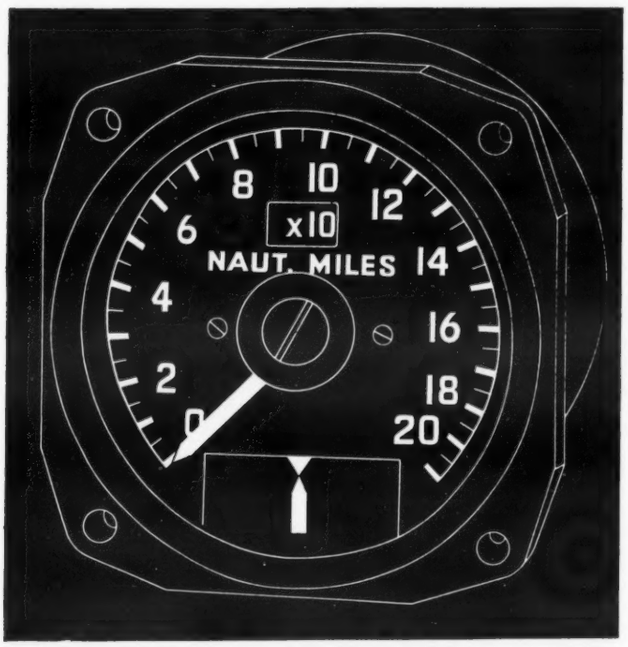

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Distributors :

Austria	Morawa & Co., Wollzeile 11, Vienna I
Canada	Wm. Dawson Subscription Service Ltd., 587 Mount Pleasant Road, Toronto 12, Ont.
	Edward Company Regd., P.O. Box 98, Station Delorimier, Montreal P.Q.
Eire	Basil Clancy, Cooleevin, Foxrock, Co. Dublin
Finland	Akateeminen Kirjakauppa, Keskuskatu 2, Helsinki
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Advertising Department, Publishing and Editorial Offices, Subscription Department :

Interavia S.A., 6, Corraterie, Geneva. Telephone: 25 42 34 (five lines). Cables and Telegrams: Interavia-Geneva. Teleprinter: 22 122. Postal Cheque Account: Geneva I 5380.

Annual Subscriptions : U.S.A. and Canada, U.S.$ 9.00; United Kingdom and Eire, £2.12.6; Commonwealth, £2.12.6; Switzerland, 32.— fr.; Austria, 190.— sch.; Belgium, 370.— fr.; Denmark, 55.— kr.; France, 3500 fr.; Germany, 32.— DM; Holland, 28.— fl.; Italy, 4640.— L. it.; Japan, U.S. $9.00; Latin American countries, U.S. $9.00; Norway, 57.— kr.; Spain, 360.— pts.; Sweden, 40.— kr. All other countries, U.S. $9.00.

Appears Monthly in Four Editions : English, French, Spanish and German

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1 hr 40 mins flying of Milan
2 hr 00 mins flying of Rome
3 hr 50 mins flying of Athens
5 hr 00 mins flying of Istanbul

* Air France is now carrying out the biggest expansion programme of its history : the " Caravelles " will be followed by four-jet Boeing 707 " Intercontinentals ".

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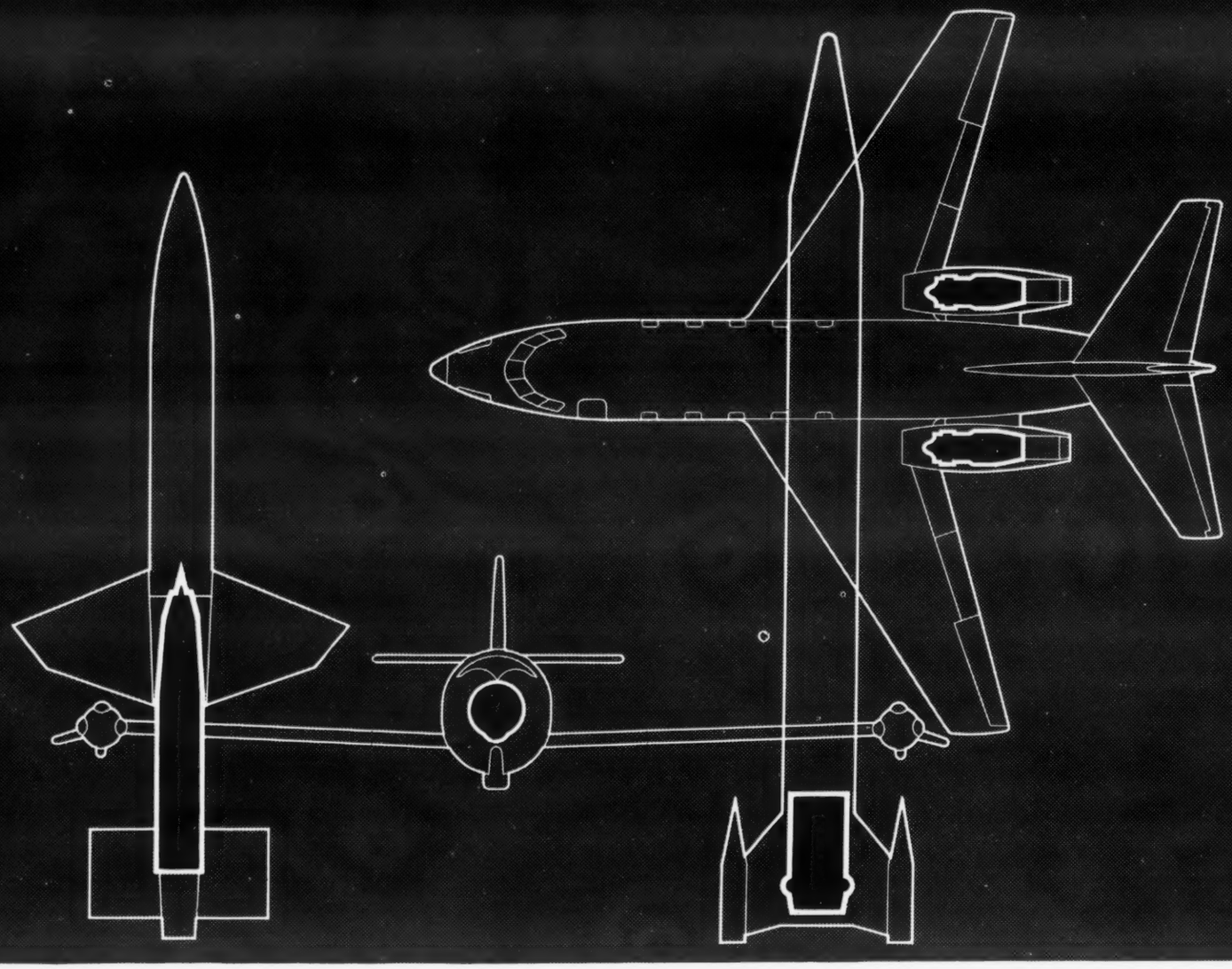

THE CHALLENGE

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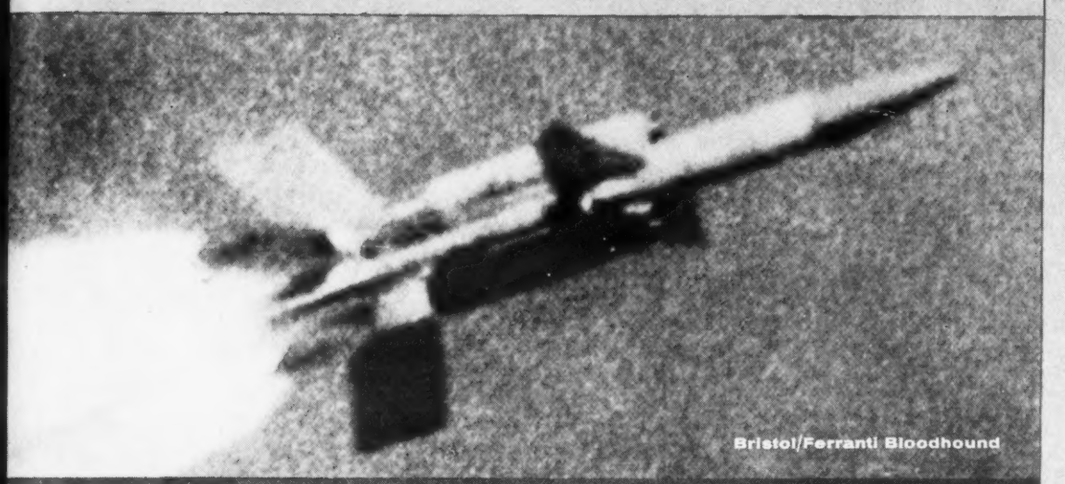
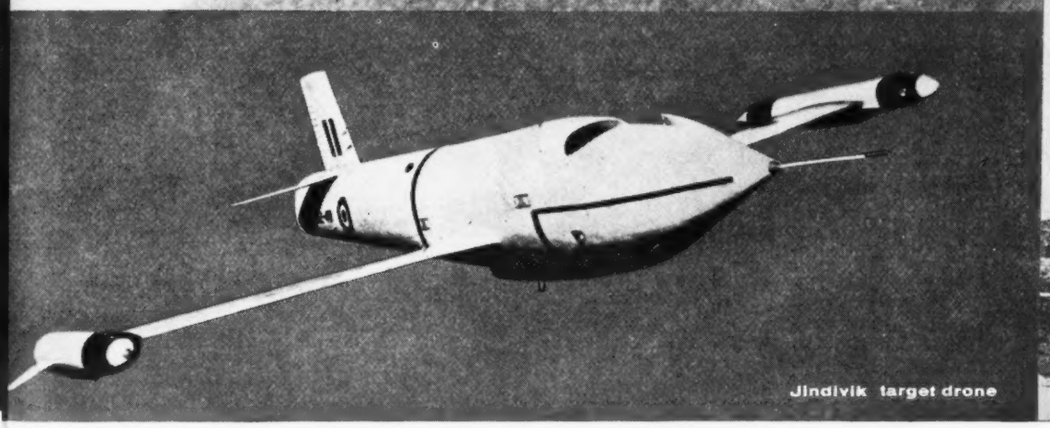
FLIGHT POWER

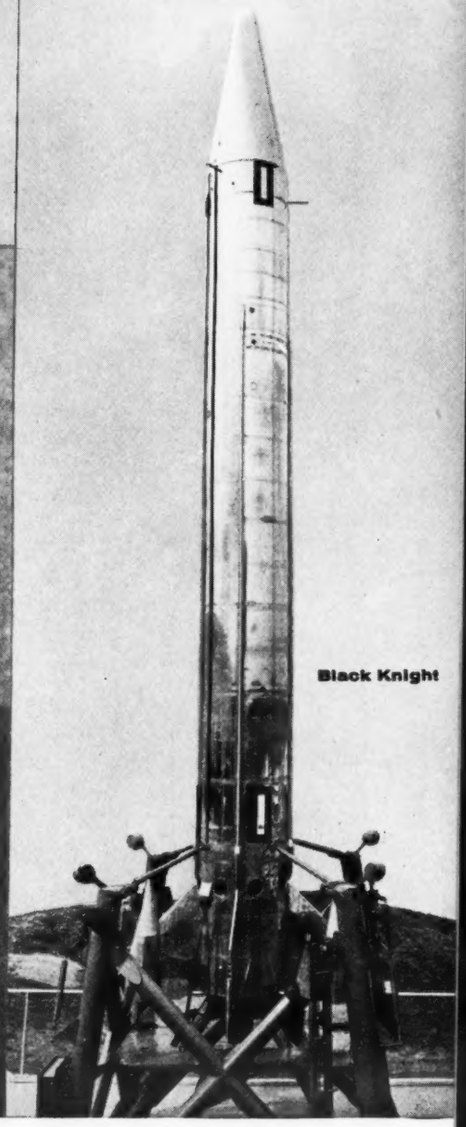
Lockheed Jetstar



Bristol/Ferranti Bloodhound



Jindivik target drone



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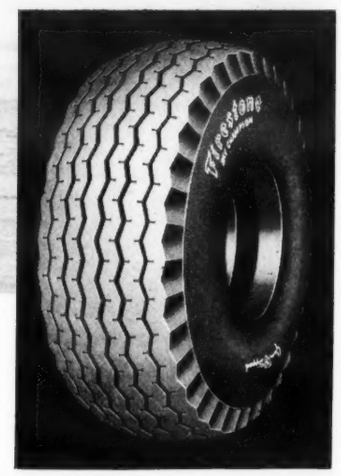

and Shock-Fortified cord resist scorching impacts, build new retreadability into aircraft tires!

Firestone Rubber-X adds new toughness and long wear to Firestone Sky Champion aircraft tires, for cut-resistant Firestone Rubber-X is made to withstand the tire-killing landing punishment of giant, multi-engine airplanes. Combined with Firestone S/F (Shock-Fortified) nylon—a new high impact tire cord — Firestone Rubber-X builds a better tire that's designed to set new standards in long original service and number of retreads. And with their ground-gripping abilities, flat profile design and S/F nylon's 40% more fiber stability, Firestone Sky Champions deliver new low tire costs-per-landing.

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*Firestone Rubber-X formulas are specially compounded for aircraft tires.

Firestone SKY CHAMPION

BETTER RUBBER FROM START TO FINISH

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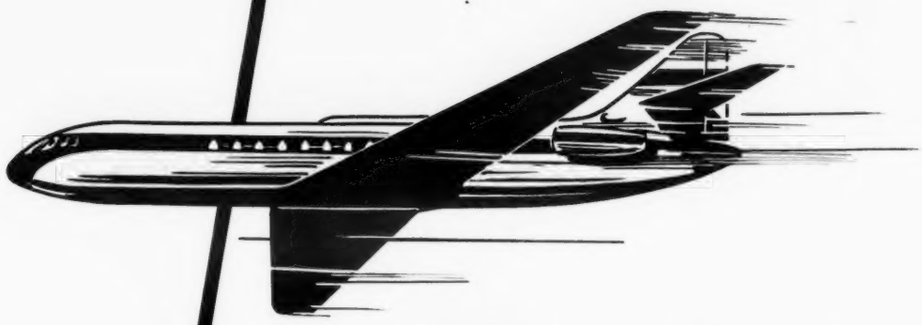

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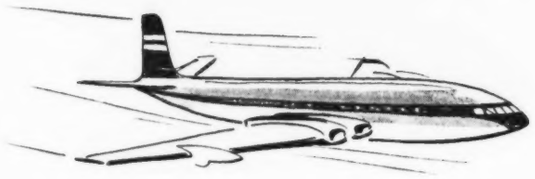

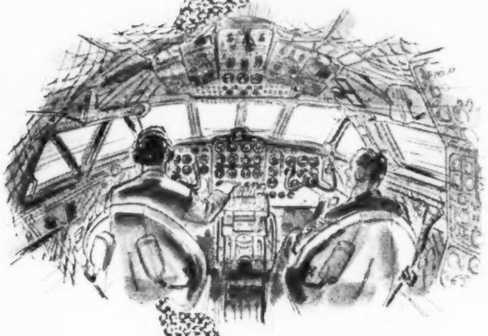

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Automatic flight progress display

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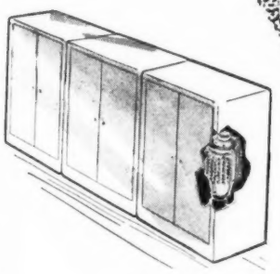

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Flight planning

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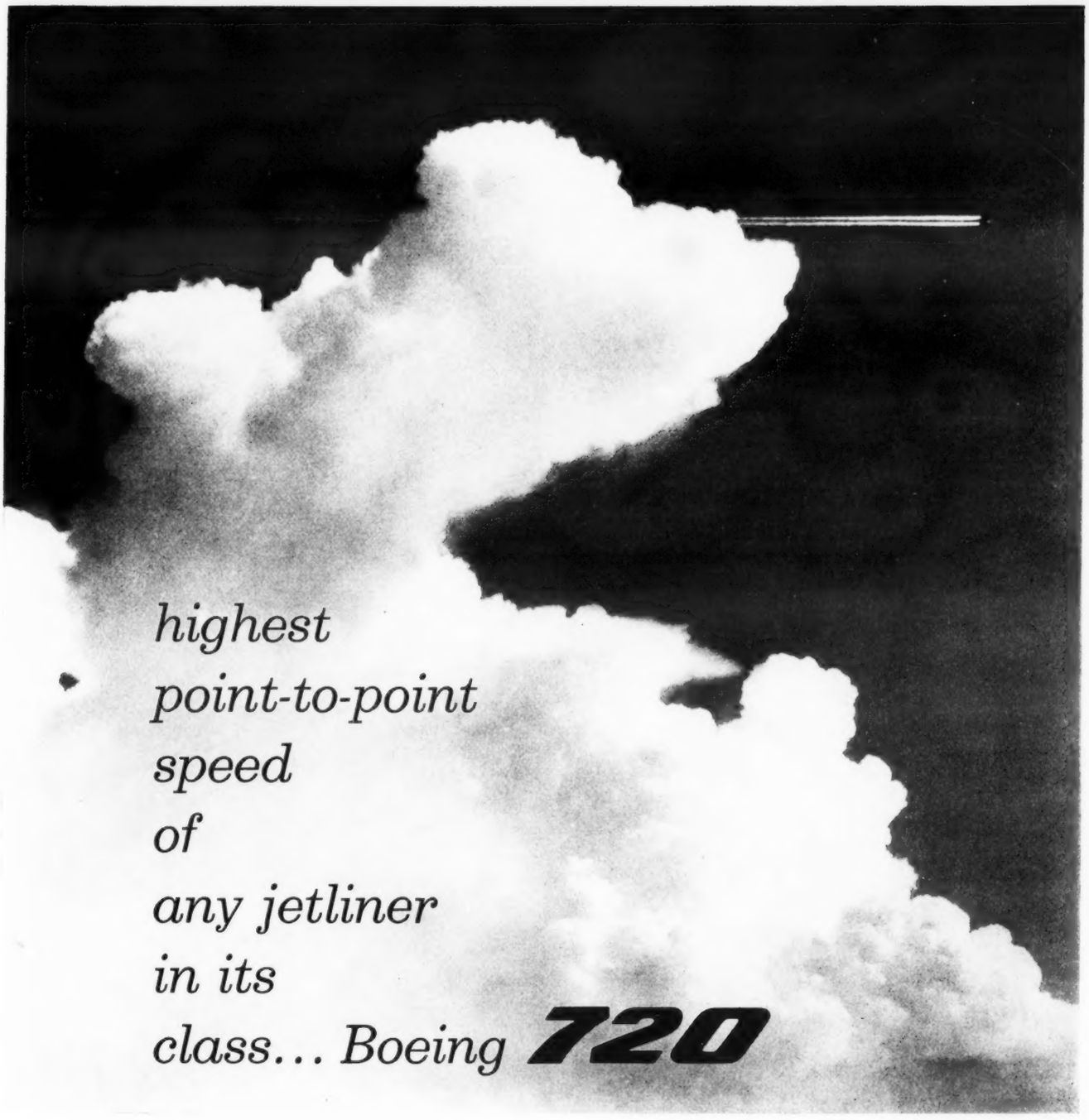

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BOEING 720

Araldite at Mach 2.8

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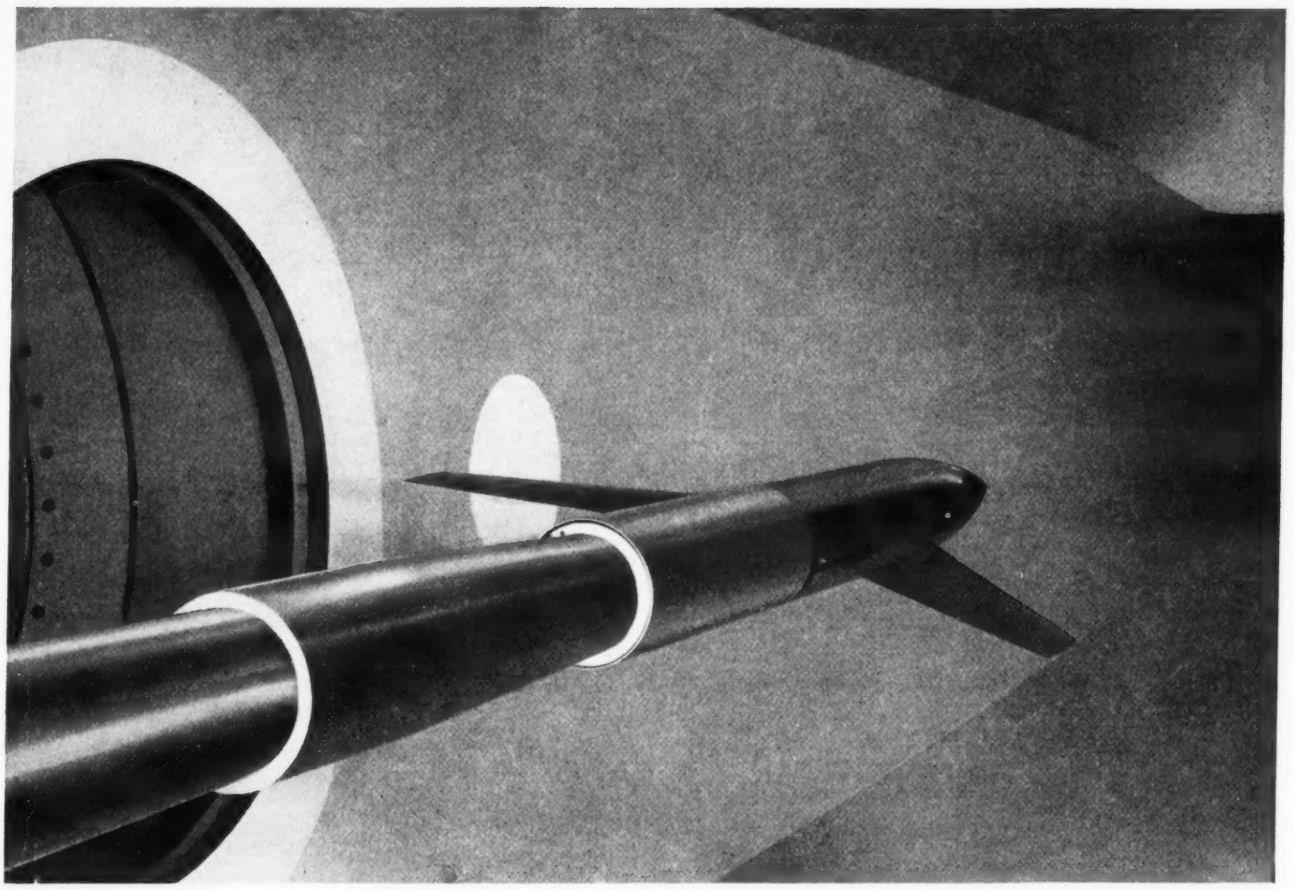

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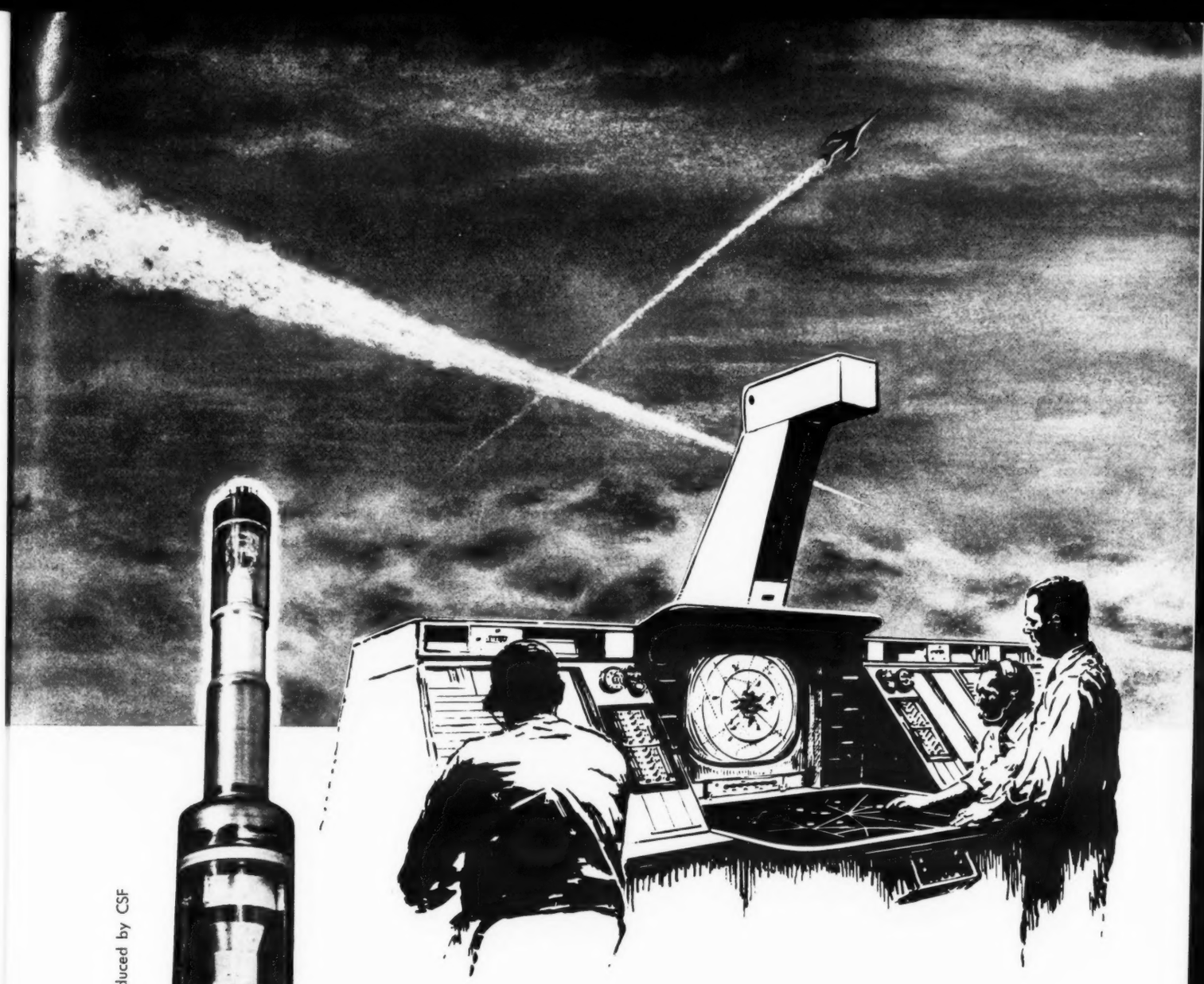

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by **retaining** the image showing the aircraft's route for several minutes, at the operator's discretion ;

by making it possible to **superimpose** on the image various service symbols, aircraft identifications, geographical features . . .

by making it possible to **transmit** the complete radar picture, via coaxial cable or long-range radio links, like a normal television programme.

Civil and military applications.

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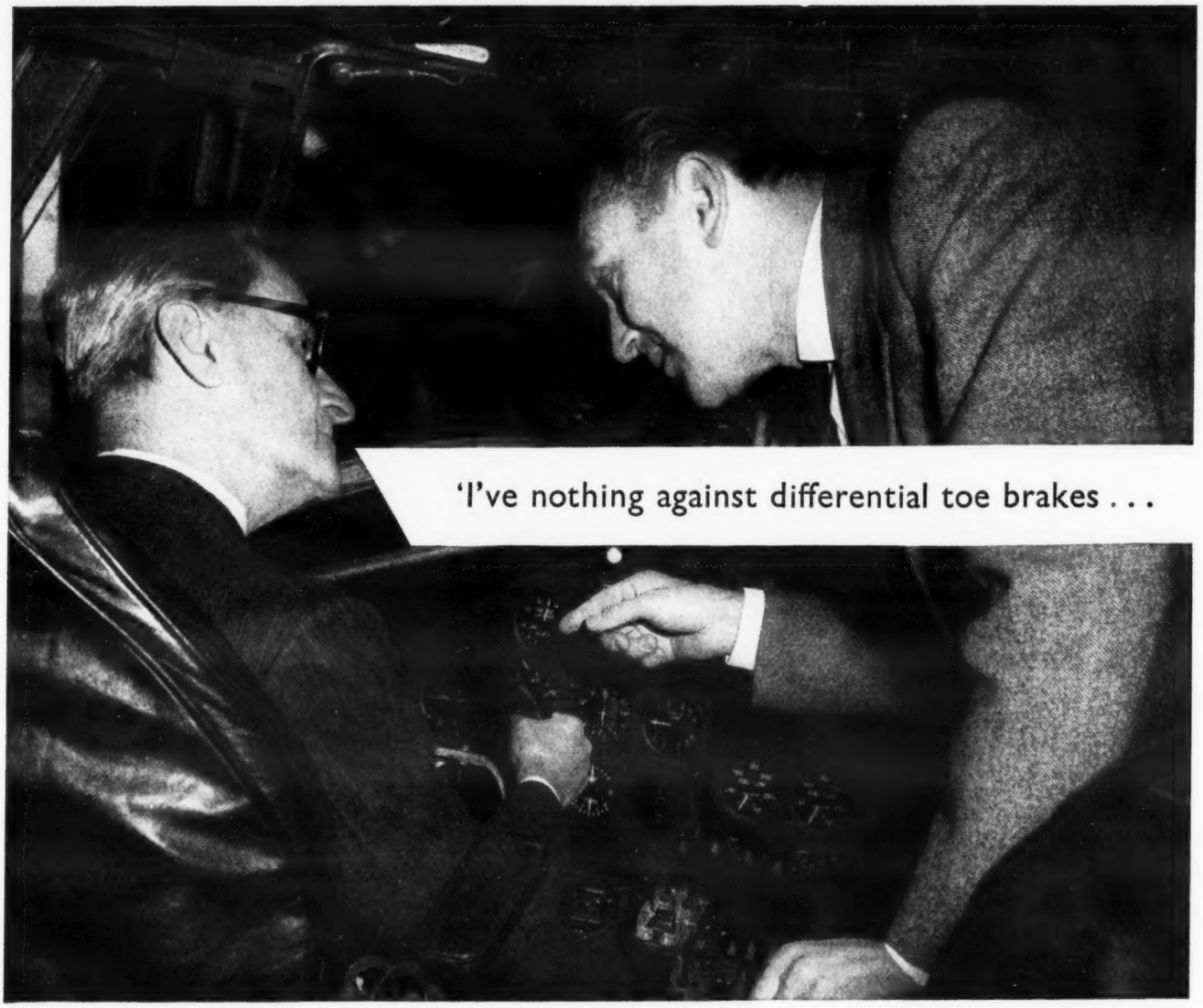

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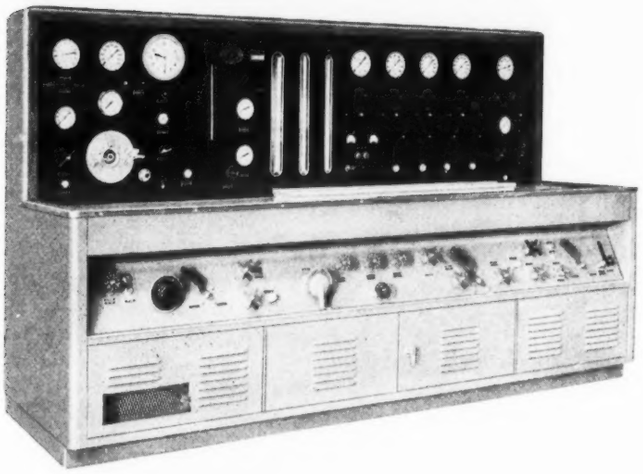

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Cabin Leakage Testers, Engine-driven Electric Power Supply Units, Jet Engine Starters and Hydraulic Test Units. Illustrated, Model S271-10G Hydraulic Test Stand. Flow ranges 10, 20, 30 and 40 gpm. Pressures to 5000 psi.

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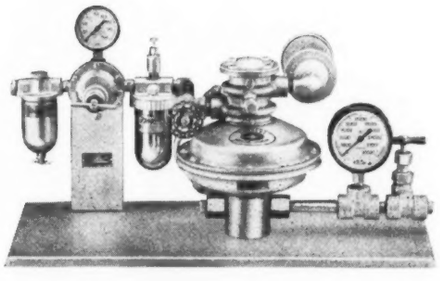
Sprague compressed air driven pumps (above), and power units (right), furnish hydraulic pressures up to 50,000 psi from 100 psi air sources. Gas boosters up to 10,000 psi. Many models available from stock. Thousands in service.



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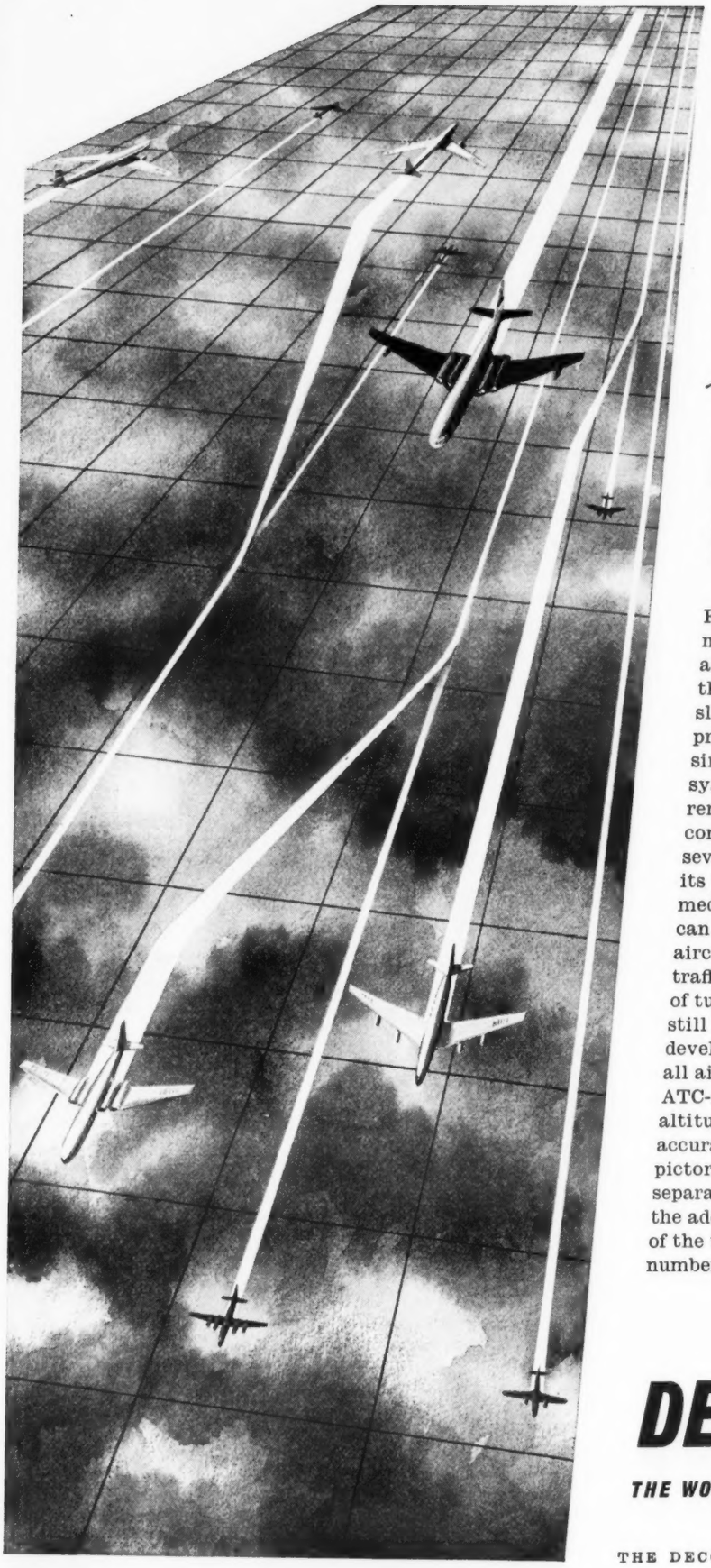

NAVIGATION for the JET AGE

From the dawn of aviation nothing fundamentally new has been added to the earliest principles of air traffic control. Until now these were founded on the requirements and limitations of relatively slow aircraft for which altitude separation was practical. Aircraft speeds and performance have since improved beyond recognition, but the basic system of navigation and air traffic control has remained virtually unchanged. Single tracks and common points of intersection are only two of the severe restrictions imposed on air traffic, threatening its very existence. The air, intrinsically a free medium, is swiftly becoming overcrowded and safety can only be maintained at the expense of inefficient aircraft operation, delays and over complicated air traffic control . . . a condition which the introduction of turbo-prop and turbo-jet aircraft will aggravate still further. Yet the answer exists today in a fully developed form. The Decca Navigator System enables all aircraft to navigate accurately and maintain any ATC-assigned track with precision, regardless of altitude, speed or weather conditions. This very accurate hyperbolic area coverage system, with its pictorial presentation, makes the introduction of lateral separation and "passing lanes" a reality. It is only by the adoption of such a system that full use can be made of the total air space, enabling the rapidly increasing numbers of aircraft to operate with safety and economy.

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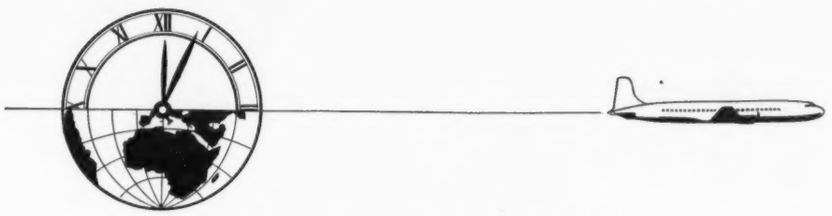

Deadline Notes

The Europair meeting convened at The Hague on April 27th did not altogether produce the expected results. Indeed, KLM has decided to withdraw from the discussions for the time being. It is understood that the Dutch carrier is at this stage unwilling to accept a final decision on the question of the proposed individual shares in the traffic of the combined companies, maintaining that there are other, more important problems to be solved first. A KLM spokesman has said that the company wants a thorough advance study of just what a joint Europair operation would involve, in order to provide a clearer picture of the costs and income distribution within the proposed cooperation. Meanwhile Air France, Alitalia, Lufthansa and Sabena have announced that they will continue working to reach agreement among themselves.

●

Trans-Canada Air Lines is offering a 35 percent increase in transcontinental tourist class accommodation this summer : TCA has introduced a fourth daily *Super Constellation* service Montreal - Vancouver, stopping en route at Toronto ; capacity will be 59 tourist and 16 first class passengers. Three new all-tourist flights : a daily service Toronto-Calgary via Winnipeg and Regina ; five services weekly Toronto-Winnipeg-Vancouver ; daily services Toronto-Montreal-Halifax ; all will be operated from June 1st to September 30th. The summer schedule also includes the introduction of a two-hour Vickers *Viscount* direct service Regina-Edmonton. Western Canada will be linked by a through service to New York with the inauguration of Vickers *Viscount* services Vancouver-Edmonton-Saskatoon - Winnipeg - Lakehead - Toronto-New York. Trans Atlantic and Caribbean flight frequencies will also be increased and a total of sixteen weekly flights will be operated to the United Kingdom and Europe during the summer months ; services to Vienna commenced on May 1st.

●

Icelandic Airlines (Loftleidir H/F) will inaugurate a weekly Friday flight from New York to Amsterdam on May 8th, with return flights departing each Sunday. The round trip fare of $453.60 will be reduced to $407.60 with the beginning of the IAL low season on August 16th.

●

Construction work on Stockholm's new £10,500,000 Arlanda International Airport is being speeded up and is scheduled for completion by 1960 to match the introduction into service of SAS's long-range Douglas DC-8 jet transports. Arlanda is to have a 10,000-foot runway, but in the first phase runway length will be 7,500 feet, adequate for the operation of the DC-8s. SAS is investing some £2,800,000 in a new hangar at Arlanda for maintenance of the carrier's DC-8s, *Caravelles* and DC-7Cs. Major overhauls on SAS jet fleets will be carried out at Kastrup Airport, Copenhagen ; the carrier's fleet of twenty Convair 440 *Metropolitans* will be overhauled at Fornebu Airport, Oslo. The present airport at Stockholm-Bromma will handle Scandinavian domestic traffic and Swedish domestic traffic operated by Linjeflyg A.B. SAS is also investing some £4 million in the construction of a new jet engine workshop at Bromma to handle much of the carrier's entire jet fleet.

●

Japan Air Lines introduced weekly all-cargo flights Tokyo-San Francisco on May 2nd, to meet the increasing air cargo demands. JAL is using Douglas DC-4s with an enlarged cargo door measuring 7 ft. 11 in. x 5 ft. 7 in. to accommodate larger pieces. Eastbound flights depart Tokyo 08:00 hours each Thursday, arriving San Francisco 04:35 hours on Fridays ; westbound services will depart San Francisco 05:00 hours Saturdays, arriving Tokyo 05:35 hours Mondays.

●

Air France carried out a most unusual air exercise on April 16th to demonstrate the gliding qualities of the *Caravelle* and the safety of this aircraft. The *Caravelle* 210-2 " Alsace ", piloted by Captain Guibert, climbed to 40,000 feet over Orly. The engines were then throttled right back (5,200 r.p.m. with fuel consumption under 500 kg/h and zero thrust). Descending at 800 feet/min., the *Caravelle* glided for 162 miles until at an altitude of 5,200 feet over Dijon, after 50 minutes flight. Despite snow flurries, Captain Guibert made a perfect landing. He reported that with an all-up weight of 83,114 lb., one engine was cut during take-off and not relit until the aircraft had climbed to 3,000 feet.

●

Another British project for a *Viscount* replacement airliner is on the drawing boards in the United Kingdom. *Interavia's* London Correspondent reports that this is also a Vickers' design and is virtually a scaled-down Vickers VC. 10. The other British design in this category, the ducted-fan Bristol 205, is in an advanced stage, and it now seems probable that the aircraft will be built ; some degree of Government backing for the project is anticipated.

●

Dornier will show two Do 27s (one equipped as a touring aircraft, the other for agricultural purposes) at the 23rd Paris Air Show, and probably the prototype of the twin-engine Do 28 touring aircraft.

●

SFASA (Service de la Formation Aéronautique et des Sports Aériens) of the Secretariat General for Civil and Commercial Aviation has changed its name. In future it will be known as Service de la Formation Aéronautique du Travail Aérien et du Transport. Offices, headed by Jean Champigneux, remain at 155, rue de la Croix Nivert, Paris (15me). Tel : VAU. 34-20.

●

Negotiations are in progress on a possible merger of Nederlandse Helicopter Industrie (NHI) N.V. into Aviolanda, Maatschappij voor Vliegtuigbouw N. V. It is anticipated that Aviolanda, who already holds NHI shares, will buy up those held by N. V. Kromhout Motorenfabriek and the Twentse Investeringsmaatschappij, Amsterdam. If Aviolanda does in fact acquire full control of NHI then it is believed that the latter's design office at present located at Rotterdam Airport, will be transferred to Aviolanda in Papendrecht. Nederlandse Helicopter Industrie was established in October 1955, and a first series of ten *Kolibrie* ramjet helicopters was put into production in 1957.

●

Jan Zurakowski, former Avro test pilot, has been awarded the 1959 McKee Trans-Canada Trophy, Canada's highest aviation award, for " his outstanding contribution to experimental test flying of jet aircraft in Canada and towards world recognition of Canadian aeronautical achievements ". Prior to his retirement from test flying last November, Zurakowski carried out the initial flying for the supersonic Avro *Arrow*, from first flight through to supersonic flight. Zurakowski lost his staff job with Avro when the Federal Government cancelled the Avro *Arrow* programme.

●

The $101.7 million U.S. Navy contract awarded to Grumman Aircraft Engineering Corporation at the end of last month for production of the A2F-1 two-seat twin-jet attack aircraft is the first to be administered by the Navy under a new " cost-plus-incentive-fee " system ; the new contractual system will increase or decrease the contractor's profit on a basis of the aircraft's actual overall performance, as well as on the contractor's control of costs. Subcontracts for the development of prototype pressurization and air conditioning systems for the A2F-1 have been handed down to Fairchild Engine and Airplane Corporation, but no value has been announced.

●

Radio Corporation of America has developed an experimental push-button communications system to permit automatic two-way radio communications between ground control and up to 500 aircraft every two minutes. Known as the Automatic Ground/Air/Ground Communications System, the device is under development for the Federal Aviation Agency as part of a long-range FAA experimental programme including electronic surveillance of aircraft on the ground. Initial models of the AGAGS equipment are scheduled for delivery to FAA in August this year for extensive flight testing. Engineering models are expected to be delivered by mid-1961.

●

Marquardt Aircraft Company is to change its name to *The Marquardt Corporation* to reflect the changed character of the business resulting from 1958 acquisitions and diversification. The board is recommending a capital stock increase from one million to two million shares with a two-for-one split in outstanding stock. The company's annual meeting is scheduled for May 5th, and the report is expected to show 1958 sales totalling $49,961,603 with net earnings, after taxes, at $1,131,294.

●

An Aero Commander Model 680-E piloted by Miss Jerrie Cobb set up a new world speed record for class C-1.d aircraft on April 13th, averaging 226.148 m.p.h. over the official 2,000 kilometre course. The previous record was established by Russian Petre Zakhoudanine with a Yak II in 1953 at 223.713 m.p.h.

●

The U.S. Air Force plans to place orders for a total of 703 new aircraft, at a total coast of $4,813,900,000, in fiscal 1960 (commencing July 1st, 1959). Included in the total are 70 additional Boeing B-52H intercontinental bombers of longer range than earlier models, 40 Convair B-58s, and 96 Boeing KC-135 tankers. The USAF plans to establish a total of 14 wings of B-52s,

and the first wing of B-58s will become operational in 1960. Orders will be placed for 24 two-seat versions of the Republic F-105 fighter bomber, plus an undisclosed number of single-seat F-105s. The programme also covers the procurement of approximately 300 jet trainers, 18 Lockheed C-130B turboprop transports and 10 jet transports. No procurement of interceptor aircraft is scheduled, but more than $500 million in the fiscal 1960 programme is earmarked for development of the Mach 3 North American F-108 two-seat jet interceptor and the Mach 3 North American B-70 *Valkyrie* bomber.

●

The USAF reports that military aircraft accidents declined 25 percent in 1958, proving that today's professional pilots can manage new high-performance equipment with increasing safety. Major General Joseph D. Caldara, Director of Flight Safety Research, said that in 894 major accidents last year a total of 530 aircraft were destroyed, 19 percent down on the 1957 figures. The accident rate has declined from about 20 per 100,000 hours of flying in 1947 (start of the jet age) to 10 per 100,000 hours in 1958. The 1958 accidents killed 302 pilots, compared with 330 in 1957.

●

The U.S. Navy's first ballistic missile submarine, the nuclear-powered *George Washington,* will be launched at Groton, Connecticut, on June 9th ; this is the sixth nuclear submarine to be produced by General Dynamics Electric Boat Division. The *George Washington,* 380 ft. long and about 6,700 tons submerged, has vertical tubes for firing the solid-propellant *Polaris* missile from either a surfaced or submerged position ; the *George Washington* will become operational in 1960, at the same time as the *Polaris.* The vessel will also have a conventional torpedo system, and will be equipped with SINS (Ships Inertial Navigation System). The nuclear-powered *Nautilus, Seawolf* and *Skate* are already in service, and the *Skipjack* and *Triton* are to be commissionned this year.

The U. S. Navy's Allegany Ballistics Laboratory near Cumberland, Md. is to have a 25,000-000-volt betatron for X-ray examination of solid propellants for the *Polaris* ballistic missile, late this summer. The betatron will provide a quick means of assuring top quality of the fuel blocks. The betatron is being produced by Allis-Chalmers Manufacturing Company at a cost of $112,325, and will be the first such X-ray application in the missile field. Hercules Powder Company operates the Allegany Laboratory for the Navy Bureau of Ordnance.

●

Ten Do 27s are to be ordered for artillery observation duties with the Belgian Army, in exchange for major armaments and munitions orders placed by the Federal Government.

●

Cleveland Pneumatic Industries Inc. will develop and manufacture nose and main landing gear for the B-70 bomber and F-108 long-range interceptor, under contracts received from North American Aviation whose Los Angeles Division is weapons systems contractor to the USAF. Cleveland Pneumatic has been selected in competition with four other companies.

●

Northwest Airlines has placed a firm order with Boeing Airplane Company for the supply of 23 Boeing 502-11B gas turbine starter units. Other airlines who have already ordered the Boeing equipment are United, Delta, TWA, PAA and Bay Aviation.

●

The Hamburg Senate has turned down a proposal for the transfer of Hamburg-Fuhlsbüttel Airport to a new location at Kaltenkirchen in Holstein. DM 12 million will now be spent on improvements to Fuhlsbüttel to bring it up to international airport standards for handling jet traffic. First step will be a DM 4.5 million programme of major extensions to the terminal buildings.

A Dassault Etendard IV M from the preproduction batch is being fitted with a Rolls-Royce *Avon Mk.51* jet for experimental purposes. The same aircraft will also be equipped with blown wings to enable it to be launched by 103-ft. catapults when carrying external loads.

●

The third prototype of the Dassault Mirage III has begun flight testing. A preproduction batch of these aircraft is now on the line.

●

Cessna Aircraft Company has announced details of its new single-engine Cessna 210 four-seat touring aircraft : high-set wing, retractable nose-wheel undercarriage, 260 h.p. Continental engine with direct fuel injection, cruising speed 190 m.p.h. Flight testing is in process, and FAA certification will probably have been granted by the time these lines appear in print. Price will not exceed $22,500 in the standard version.

●

Pilatus Aircraft Works, of Stans, Switzerland, has taken over the agency for the Klemm K1 107B sports and touring aircraft in Switzerland ; a demonstration aircraft of this type has recently been flown to Switzerland.

●

The Pilatus PC.6 small transport (accommodation for a pilot and five passengers or roughly, 1,100 lb. of freight) is scheduled to begin flight testing in the second half of May, 1959. This aircraft is powered by a Lycoming GSO-480-A1A6 engine of 340 h.p.

●

De Havilland is at present investigating the market prospects for a projected DH.123 turboprop airliner, described as a DC-3 replacement. This aircraft will have DC-3 capacity and very good short field characteristics. Engines will be two of the 1,000 h.p. turboprop version of the *Gnome,* which is now being built by de Havilland Engine Company.

●

The Sikorsky S-60 crane helicopter was demonstrated publicly for the first time on April 13th, 1959. Powered by two 2,100 h.p. Pratt & Whitney R-2800 engines, this unusual load-carrying vehicle can transport four to six tons over distances of up to 100 miles. If gas turbines are fitted instead of the piston engines, payload can be increased by a further 2.5 tons. The crane helicopter carries its loads on cables beneath the fuselage, which consists in essentials of a bridge-like boom of box-shape section stretching between the glass-enclosed cockpit and the tail rotor. Also available are specially designed detachable pods to carry weapons, troops or equipment.

●

Fairchild Engine and Airplane Corporation has received full FAA certification for use of the Rolls-Royce RDa.7/Mk.528 *Dart* propeller turbines on its F-27. With this larger version of the *Dart,* the F-27 will be known as the F-27A.

Workshop Briefs

The Grumman YAO-1 Mohawk Army observation aircraft began flight testing on April 13th, 1959. Power is supplied by two Lycoming T53 propeller turbines of 1,005 e.h.p. each. Max. speed roughly 275 knots.

●

The Saunders-Roe plant in the Isle of Wight is completing construction of a new-type hovering craft which can best be described as a cross between an aircraft and a ship. The vehicle, known as the SR N1, is based on patents taken out by C. S. Cockerell and is designed to glide over the water supported on a "cushion" of air and propelled by a rearward-thrust jet.

●

The Northrop T-38 Talon twin-jet supersonic trainer took off on a 42-minute first flight at Edwards AFB, California, on April 10th, 1959. At the controls was Northrop Chief Test Pilot Lew Nelson, who took the aircraft to an altitude of 35,000 ft. and carried out tests in the near-sonic range. Take-off weight of the trainer, with its two J75 jets, was roughly 11,000 lb. The flight test programme for the T-38 is being carried out jointly by Northrop Corporation and the ARDC's Air Force Flight Test Center, Edwards. Meanwhile, the manufacturers have also announced that the prototype of the N-156 F supersonic fighter, developed in parallel with the T-38, will leave the assembly shop at the end of May and begin flight testing during the summer.

●

New Lockheed Transport : During the World Congress of Flight at Las Vegas Robert J. Mitchell, Director of Sales for Lockheed's Georgia Division, announced that his company plans to develop a strategic turboprop transport to be designated the *Super Hercules.* Using external tanks the aircraft will be capable of carrying a payload of 32,000 lb. over distances of up to 5,500 miles. The *Super Hercules,* an improved and bigger version of the C-130 *Hercules,* will be offered in both a military and a civil model. Under present Lockheed plans, the fuselage will be 23 ft. 4 ins. longer than that of the C-130B, and wing span will be increased by 13 ft. The height of the vertical tail will be unchanged. Gross weight is expected to be roughly 204,000 lb.

●

Nord-Aviation has already delivered more than 23,000 SS.10 and SS.11 anti-tank missiles, and several more tens of thousands are on order. In addition to France, ten other countries have bought these missiles, the biggest customer being the United States.

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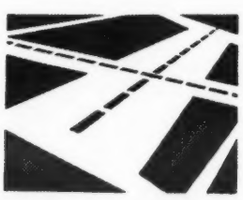

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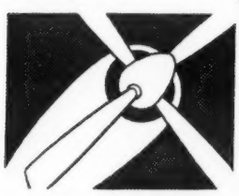

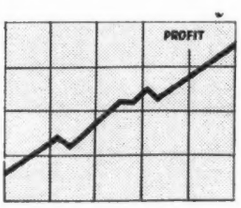

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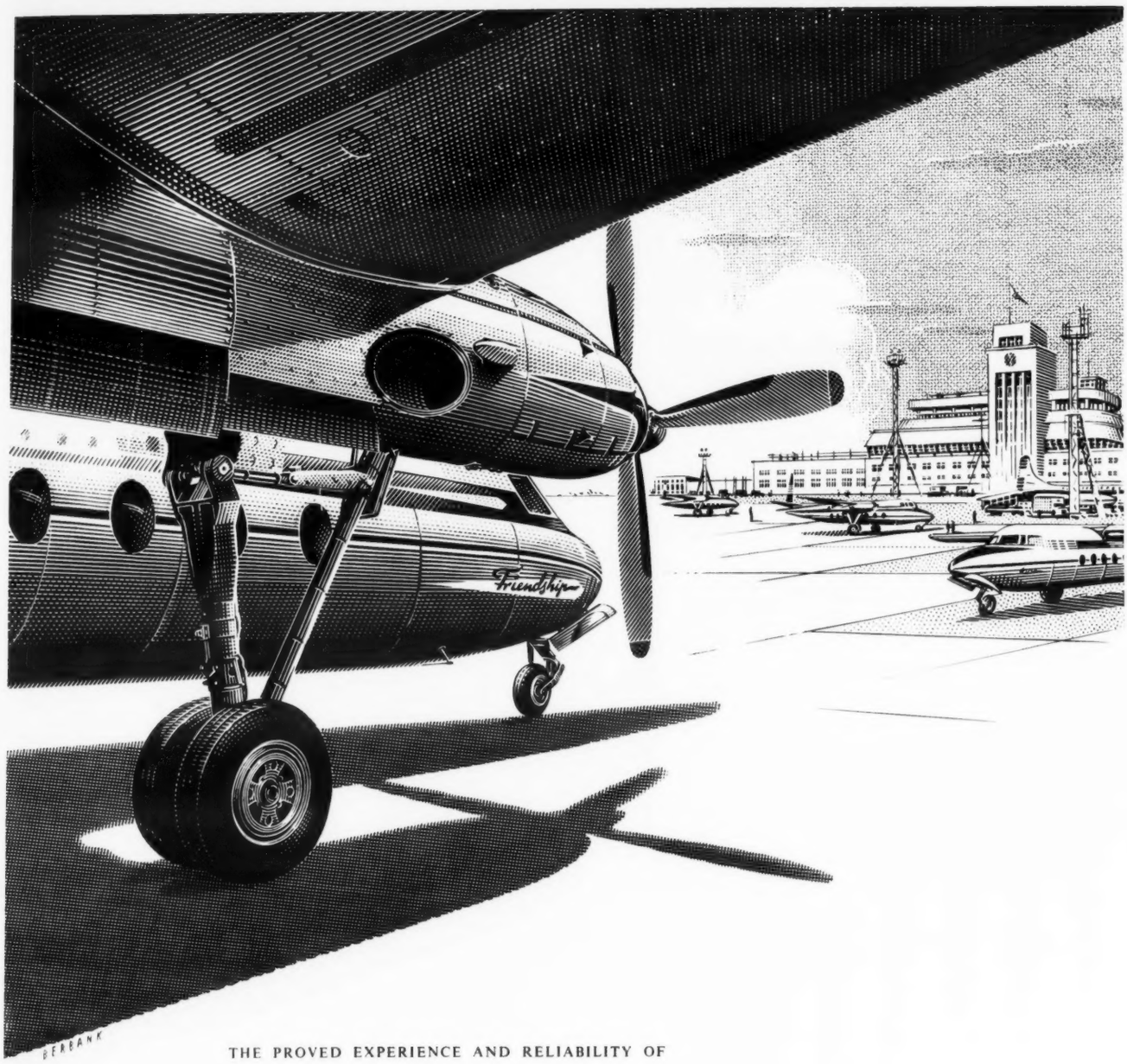

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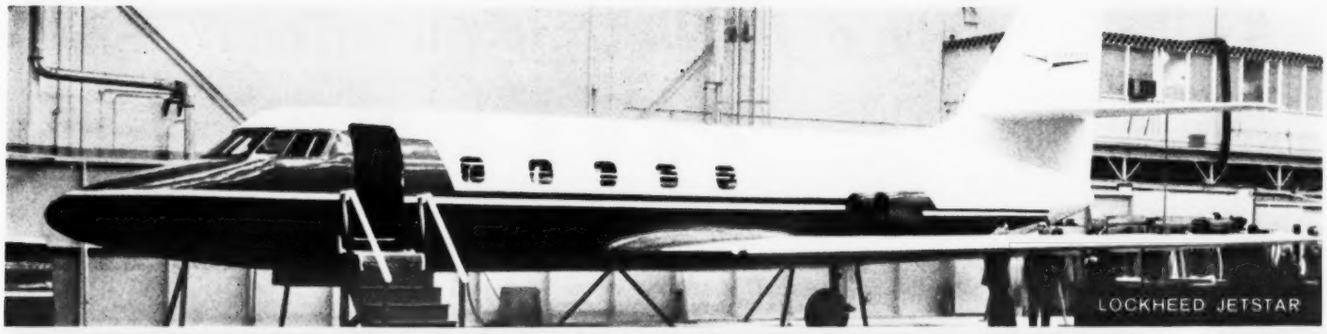
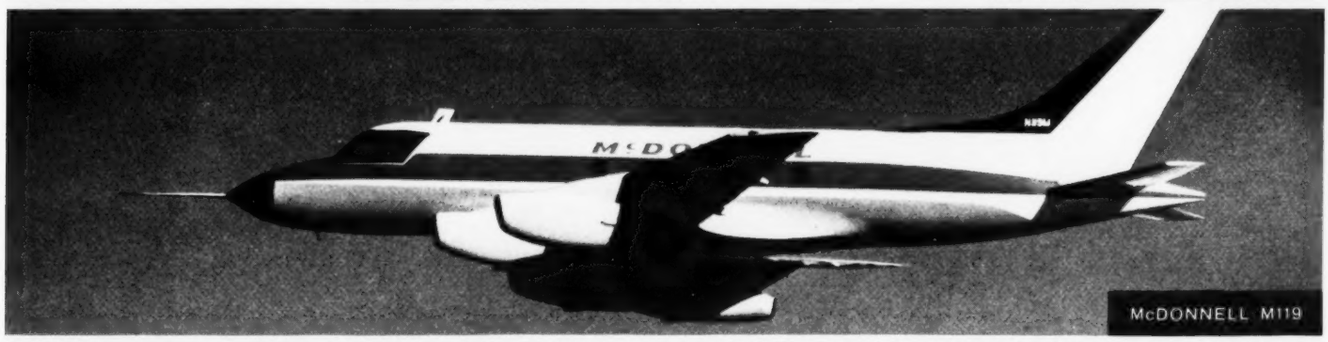


LOCKHEED JETSTAR



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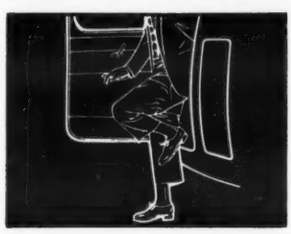

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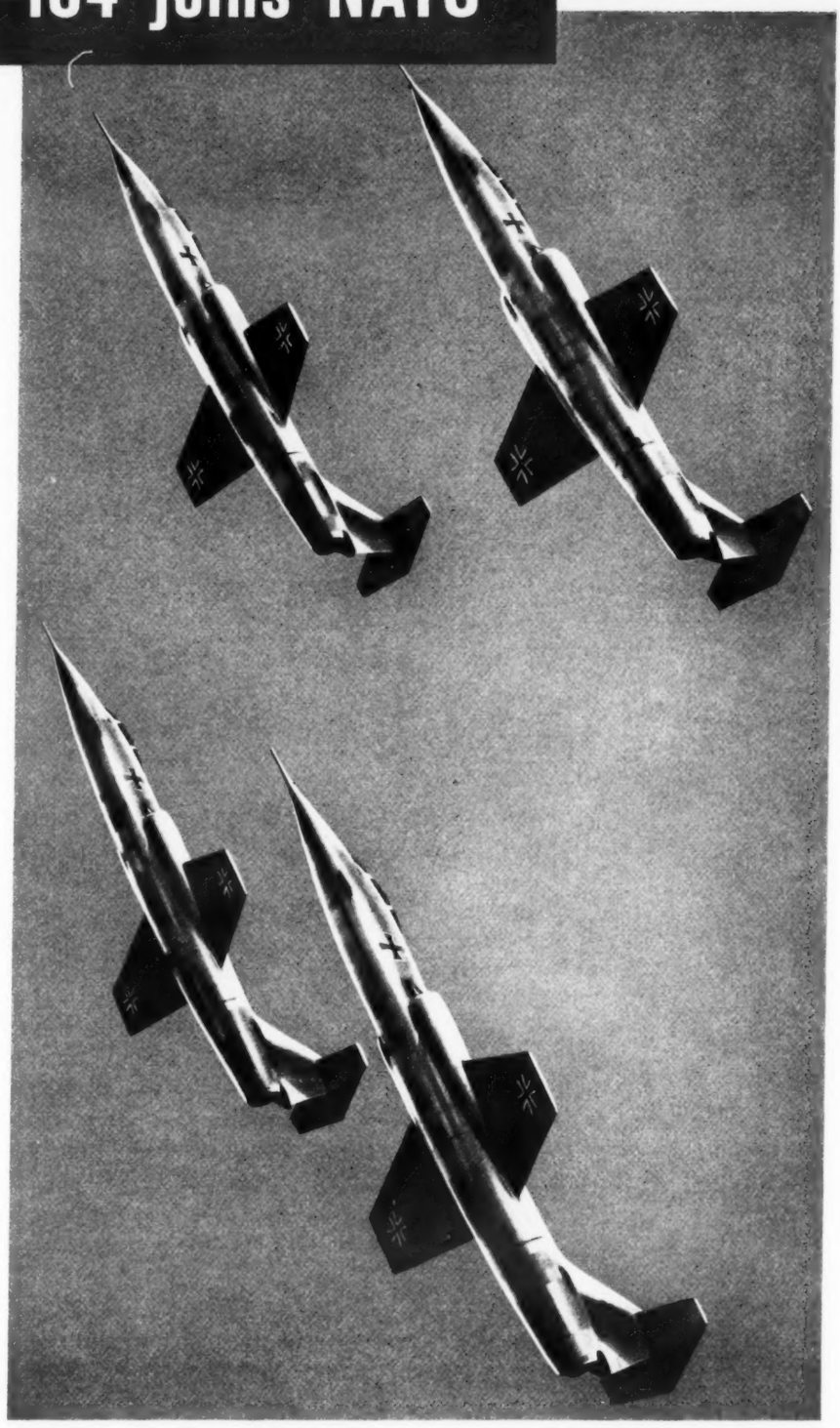
Lockheed's F-104 joins NATO



After a two-year evaluation period during which West German Defense Ministry experts investigated and flight tested airplanes made by 12 competing manufacturers, the plane selected for purchase and manufacture under license in West Germany is Lockheed's famous "missile with a man in it" – the *F-104 Starfighter.*

Never before has a single airplane done so many things so well as the present U. S. Air Force version: Interception, Air Superiority, Ground Support and Reconnaissance – and with so low *proven* maintenance and operating costs.

Holder of the world speed, altitude, and seven time-to-climb records, the current F-104 will be still further developed to meet the specific needs of West Germany and other allies requiring a multi-purpose fighter instead of several separate aircraft for specialized needs. To its already amazing performance is being added all-weather capability for fighter bomber and interceptor missions and also an advanced reconnaissance capability.

The licensing of German manufacturers to produce this advanced version will make it available to West European nations at relatively low cost.

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Other airframe manufacturers, like Convair, find the extra temperature range performance of Auto-Lite 350 Wire ideally suited to jet aircraft demands. Many manufacturers find that in addition to its high resistance to abrasion, flame, solvents, fuels, and lubricants, Auto-Lite 350 Wire reduces production costs, too, compared to other high-temperature wires.

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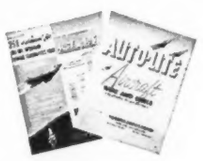
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demonstrated by new

Britannia 312's play leading part in first-ever round-the-world jet airliner service*

Latest evidence of Britannia dependability and operating economy is provided by BOAC's enterprise in setting up the first-ever round-the-world jet airliner service. This achievement by a British airline using British aircraft makes it possible to fly round the world in 3 days, 14 hours, 50 minutes—less than 87 hours, a figure expected to be reduced soon to under 80 hours.

Britannia versatility brings profit to operators

Already Britannia routes encircle the earth, service almost every major city in the world. Britannias fly over 2½ million miles a month; show unique range flexibility by covering stage lengths ranging from 300 miles inter-city to nearly 5,000 miles transpolar. They make no special demands on length and strength of existing runways.

At the same time Britannias are attracting new traffic with their quiet comfort and cruising speeds of over 400 mph—at least as high as any turboprop or piston-engined airliner in service anywhere in the world today. They prove their versatility by carrying a tremendous variety of freight loads, and bring profit to operators.

New traffic

Since introducing Britannias, El Al Israel Airlines have trebled their share of transatlantic traffic, while Canadian Pacific Airlines on their transpolar Vancouver-Amsterdam route in 1958 gained a 32% increase in westbound traffic over the same period of the preceding year.

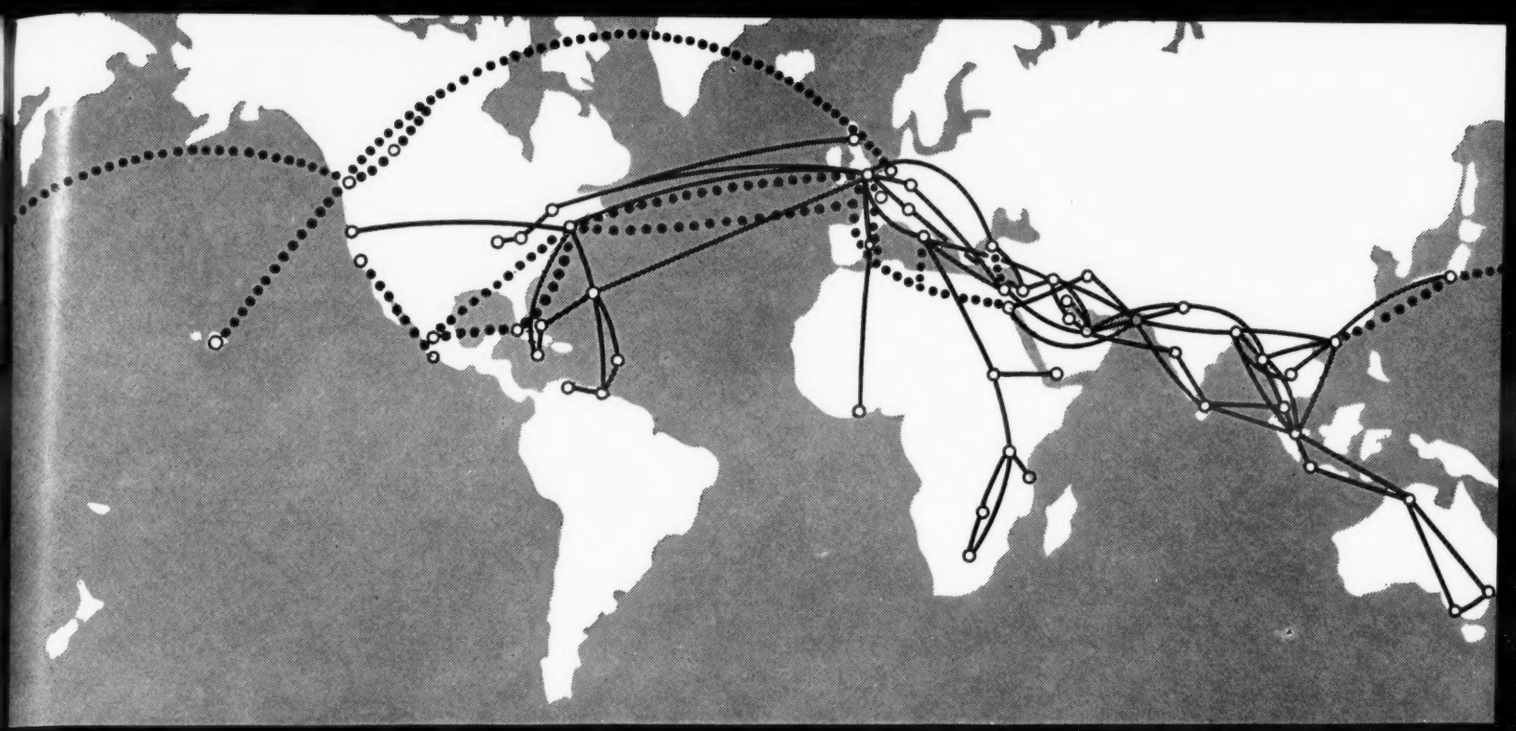
Big charter assignments

Air Charter Ltd. Britannia flights between Christmas Island and Great Britain have been carrying no less than 128 persons —largest-ever passenger loads regularly carried across the Atlantic by a civil operator. Only 15 days after receiving their first Britannia. Air Charter had completed a full route-proving programme across the Atlantic and Pacific; the aircraft was thus earning money almost at once. Furthermore, in its first three months, it achieved an average utilisation of 7.28 hours a day.

Hunting-Clan Air Transport experience, too, has proved the Britannia unequalled at carrying large payloads at high speed over long distances. Recently a Hunting-Clan Britannia flew round the world in 65 hours flying time—a distance of 24,000 miles at an average speed of 374 mph. On the Christmas Island-London leg of the flight the aircraft was carrying 127 persons.

Engine reliability

Britannia operating economy is rooted particularly in the proven reliability of its Proteus engines. Overhaul life on the Proteus 705 series reached 2,000 hours in under 2 years. No

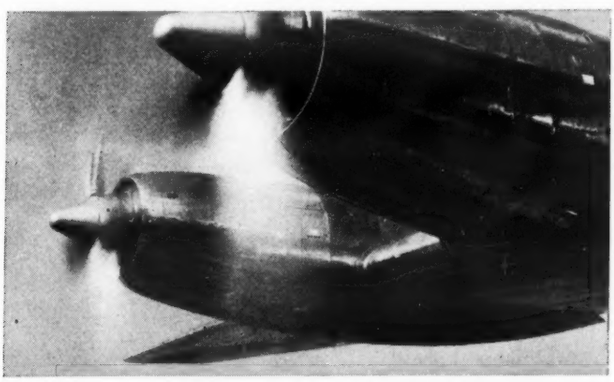


Britannia routes encircle the earth, service almost every major city in the world

BOAC, CAA, EAA, GHANA AIRWAYS———
EL AL, CPA, AERONAVES, CMA, CUBANA .....

reliability, profitability BOAC enterprise

engine of comparable power in service today has an overhaul life that even approaches this length. Annual engine overhaul costs for BOAC's Britannia 102's have been cut by 75% since the aircraft went into service. Continued development will give Proteus even longer overhaul life, entailing even lower operating costs.



Meanwhile, current versions of the engine give greater power, lower fuel consumption, and materially improve the Britannia's cruising speed, range, and take-off performance.

Finally–Britannia overall profitability is evidenced by airline experience. *El Al's Britannias are operating at a ton/mile cost approximately 20% less than any previously experienced.*

Other recent Britannia airline achievements

BOAC extend Britannia services—to Venezuela via Bermuda, Nassau; across USA to San Francisco; and via Montreal to Detroit and Chicago.

Ghana Airways—a BOAC associate—introduce Britannias on weekly London-Barcelona-Accra service, April 14.

Aeronaves de Mexico Britannia services have been slicing more than an hour off previous Mexico City-New York schedules. Now an Aeronaves de Mexico Britannia has flown Mexico City-New York in 4 hrs 57 mins (437 mph), beating own record (of 5 hrs 2 mins) made only the previous week. Load factors have been extremely high.

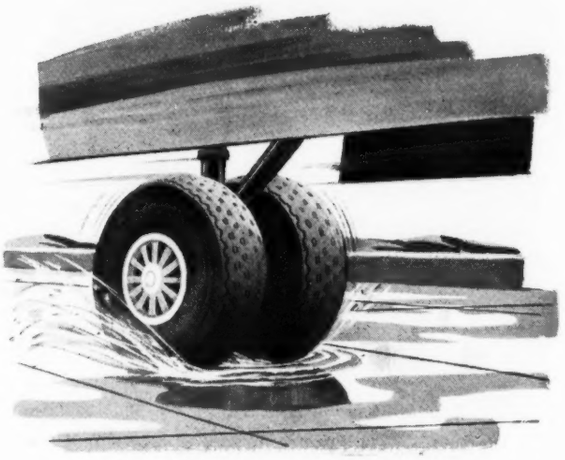
Cubana de Aviacion fly return journey after inaugural flight Havana-Mexico City in record-breaking 2 hrs 53 mins—shortly to set up Britannia services Havana-New York, and transatlantic via Azores to Madrid.

* *Subject to Governmental approval.*

BRISTOL
Britannia

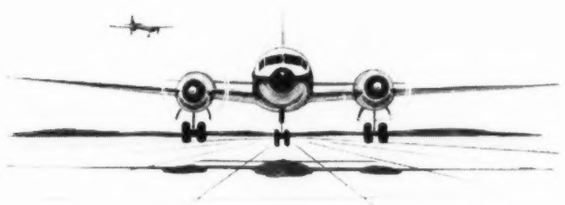
BRISTOL AIRCRAFT LIMITED

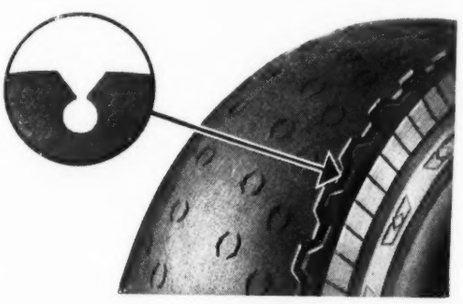
NOW—AN **ALL-PURPOSE** TIRE THAT SOLVES **SPECIAL** TIRE PROBLEMS!



1 **ROUGH RUNWAYS CUTTING INTO TIRE LIFE?** The new Hi-Lander Tire by Goodyear offers exceptional resistance to cutting, chunking, peeling. The result: minimum carcass damage even on roughest fields; thus, far greater retreadability. Unique design also prevents tread stripping, makes possible up to 20 per cent more landings per tread.

2 **HYDROPHILIC CONDITIONS CAUSING TRACTION LOSS?** There are no "pockets" in Hi-Lander tread to trap water during landings on wet runways. "Trapped water" between runway and tire can result in temporary—*but critical*—loss of traction and pilot control. This dangerous "cushion of water" cannot possibly form under tread of Hi-Lander Tire.





3 **ON SMOOTH, HOT RUNWAYS** Hi-Lander Tire provides efficient heat dissipation even at high landing speeds. Tire is an ideal choice for tandem-type bogie aircraft. Reason: tread will not peel when wheels are subjected to sharp turns. Remarkable strength of Hi-Lander comes from famous Goodyear *triple-tempered* nylon cord construction.

4 **ON ALL RUNWAYS,** zigzag groove of Hi-Lander assures greater directional stability – increases braking traction. Notice that groove is V-shaped and key-slotted. This keeps tire from picking up and throwing stones on loose-surface runways—a problem which can result in fuselage damage. Hi-Lander design *saves* this maintenance cost.

WANT MORE INFORMATION on the Hi-Lander? Simply write Goodyear International Corporation, Aviation Products Division, Akron 16, Ohio, U. S. A., or The Goodyear Tyre & Rubber Company (Great Britain) Ltd., Wolverhampton, England.

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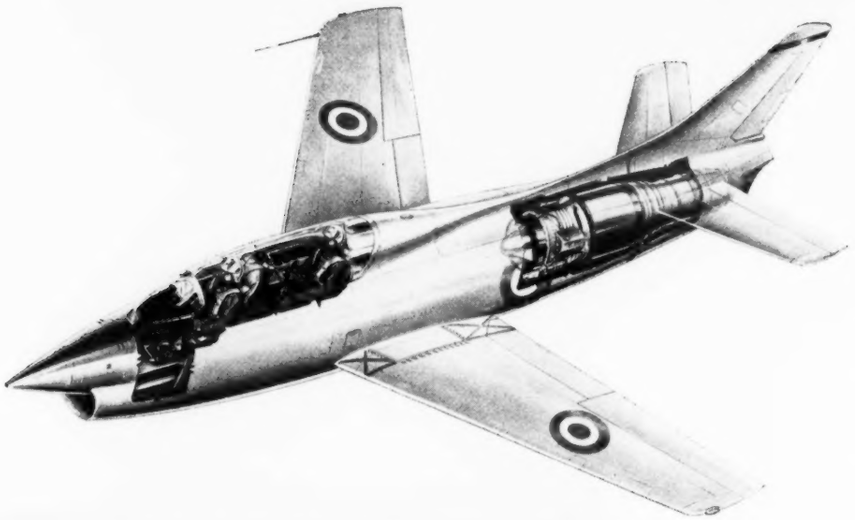

FIAT G 91 T

Bristol Orpheus 80302

The jet trainer, with characteristics and performance similar to those of the lightweight strike fighter version, is an aircraft especially developed for advanced training up to supersonic speeds. Meets all the requirements of the latest NATO standards and ABC agreements.

FIAT G 91

Bristol Orpheus 80302

The light strike fighter, winner of the NATO contest. Basic advantages :

— ability to operate from a small space on semi-prepared strips or grass runways.
— small in size, light in weight, easy and comfortable to fly, low unit and operating cost.
— versatility and maximum defensive and offensive efficiency with its basic and auxiliary weapons.

FIAT G 91 R

Bristol Orpheus 80303

Photographic version of the light strike fighter. It is capable of performing day missions at high speed and low altitude, taking photographs forwards, backwards and to right and left simultaneously, or vertical photographs.

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CANADAIR CONVAIR 540

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The " 540 " combines the airframe of the world-renowned Convair " 440 " Series ... proved in over 6,000,000 hours of service ... with Napier Eland 3,500 e.s.h.p. jet-prop engines. The result is a fast, flexible new aircraft that has excellent performance characteristics and earning power.

FIRST — The Canadair-Convair 540 is the *first* airliner with engines specifically designed for the rigorous up-and-down life of short stage operations, and offers a new standard of economy.

FIRST — The *first* airliner with such great growth potential. Standard seating capacity of 48 can be increased by 20% to 58, still with three feet of leg room per seat. This growth potential, plus the proved performance of the airframe, means a useful life of at least 15 years.

Here are more examples of its outstanding characteristics.

- **FASTEST IN ITS FIELD** — Up to 340 m.p.h. at 20,000 ft.
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- **LOW OPERATING COSTS** — As economical as a piston aircraft in stages as short as 80 miles ... simplified maintenance lowers cost of training.
- **EXTRA FUEL CAPACITY** — Sufficient for most routes terminal to terminal ... three 350-mile stages without refuelling and without weight or space limitations.
- **GOOD EARNING ABILITY** — Profitable even with moderate payloads.
- **CARGO AND EXPRESS CAPACITY** — An additional profit opportunity: 788 cubic feet of easily accessible space.
- **QUICK TURNAROUND** — Self-service baggage racks and self-contained stairway speed departures and arrivals.

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The Canadair-Convair 540 is a product of the combined experience and facilities of two of the world's great aircraft producers — Canadair Limited of Canada and Convair — both members of the General Dynamics family of companies.

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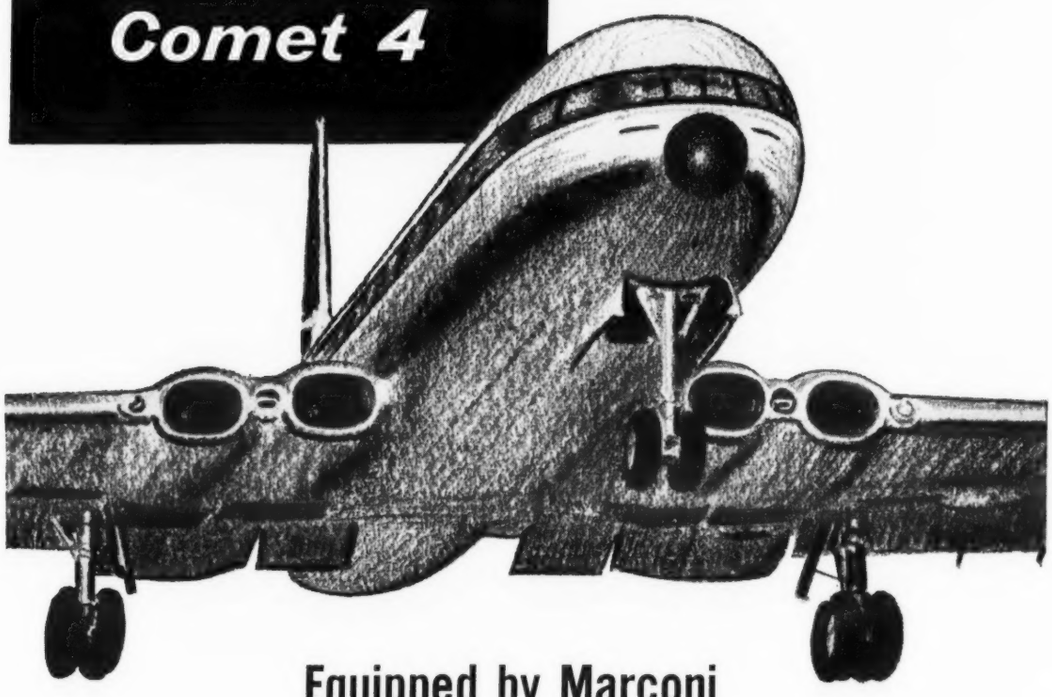
Marconi in the Comet 4



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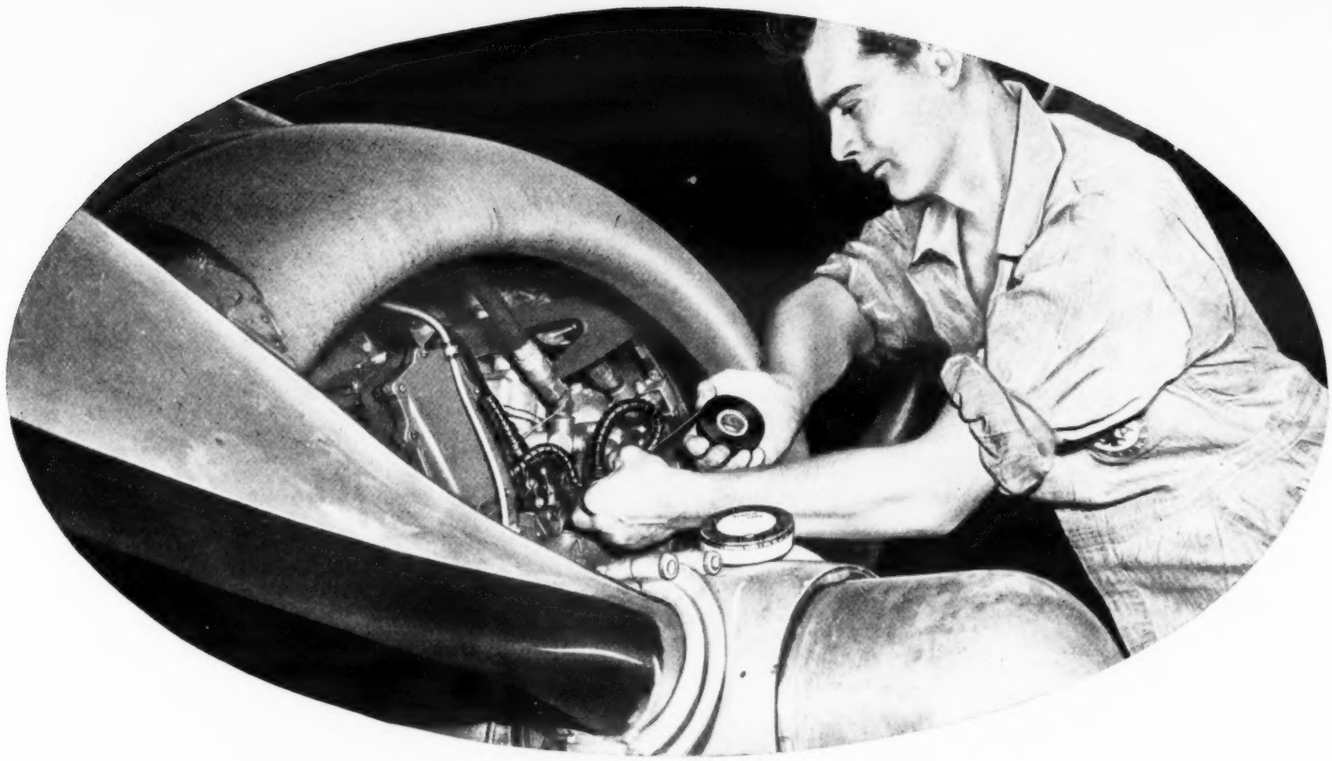

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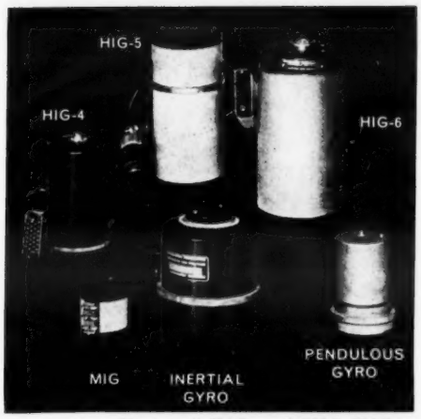
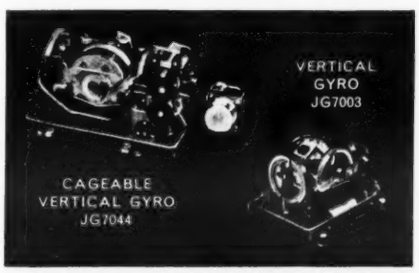


Honeywell HIGs and MIG, HIG-6, Inertial Gyro, HIG-4, MIG, HIG-5, Pendulous Gyro

Honeywell's Gnat

Honeywell's RAM



Honeywell's Cageable Vertical Gyro, JG7044 and Vertical Gyro, JG7003

Honeywell's Rate Gyro, JG7005, Rate Gyro, GG13 and Miniature Rate Gyro, GG16

A GYRO TO MATCH THE NEED

No single gyro can meet all applications. Far from it. Yet with the broad Honeywell line you can meet most applications.

Take, for example, the gyros shown at the left:
The *HIG (Hermetic Integrating Gyro)* line of floated gyros includes the world's most accurate production gyros. Each of the three models has special characteristics to cover a variety of applications in fire control, missile stabilization and inertial guidance systems.

Honeywell *MIG (Miniature Integrating Gyro)* is primarily used in stable platforms and excels in short-time inertial and aided-inertial applications.

The Honeywell *Gnat* is a sensing device in flight control systems and keeps aircraft weighing many tons "on course" and missiles traveling at supersonic speeds "on target."

Honeywell's *RAM* is a new 2-axis gyro designed to withstand missile shock and vibration. Maintains tight accuracy under high acceleration and severe vibration.

Honeywell's *Cageable Vertical Gyro* is ideal as a vertical reference for use in radar stabilization, fire control, bombing, navigation and flight control systems. Has the fastest caging action available today. Honeywell's *Vertical Gyro* is a proven vertical reference gyro with unusual reliability. Presently being used on autopilots, missiles and navigation systems.

Honeywell's Rate Gyro, JG7005, is a general application gyro whose dependability and accuracy has been proven in a multitude of aircraft control systems. The GG13 is a non-floated, damped Rate Gyro which is extremely rugged and lightweight. The Miniature Rate Gyro, GG16, is dependable and rugged for missile and flight control applications.

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Stabilizing Market Prices for Used Aircraft

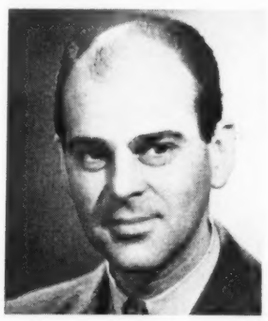
by Robert I. Helliesen, President, Aircraft Exchange, New York

For many months past air transport organizations, airlines and the trade press have been debating the delicate question of how the airline industry can dispose of its fleets of surplus piston-engine aircraft under the most favourable conditions, so that the proceeds can be used towards payment of the new jet transports on order. If each airline acted independently in this sales campaign, the result would inevitably be disorganization of the market and a drastic fall in prices. An attempt was therefore made in the United States at the beginning of 1959 to regulate supply and demand through the creation of an exchange for the purchase, sale and lease of used transport aircraft : the Aircraft Exchange Inc., *with offices in New York and London, regularly lists bids and offers for all types of airliners with a weight of more than 20,000 lb. and supplies its members - airlines, aircraft manufacturers, dealers, etc. - with weekly market reports.*

In the following article Robert I. Helliesen, President of Aircraft Exchange, reports on the market situation in the first quarter of 1959. — Editors.

The Aircraft Exchange began operations in the used transport aircraft market in January of this year and quickly received evidence of the widespread interest in the purchase, sale and lease of transport aircraft. Airlines from all over the world responded to our invitation to become affiliated with the Exchange.

However, as of January, there was some question as to whether the interest was strong enough to cause planes to change hands. Traffic was still in the 1958 doldrums, though there was the chance of a substantial upswing in the spring and summer of 1959. Deliveries of new planes were crowding in upon some airlines, but



Robert I. Helliesen (left), President, and Ch. N. Biondi, Vice President of Aircraft Exchange.

uncertainty as to what to do with the replaced aircraft was still the keynote of the January market. Offering prices were on the high side and bidding prices on the low side.

During the month of February a transition began which became even more pronounced during the first half of March. Traffic in many areas of the world seems to have picked up, and as prospects grew brighter for strong summer traffic, bid prices for aircraft went higher.

Most of those bidding for piston-engine planes currently appear interested in short term commitments of from six to eighteen months duration. Many bidders would like options either to purchase the used aircraft or extend the lease at the end of the six to eighteen month period, which indicates that uncertainty as to the future values of aircraft still exists.

This uncertainty about the future is, of course, one of the features of the market that the Aircraft Exchange hopes to correct. We are currently endeavoring, and we believe with some success, to encourage our members to submit futures quotations. They should become more willing to do so after the operation of the Exchange over a longer period has helped to stabilize current values and has begun more definitely to highlight trends which can be a guide to the future.

There are well over 4,000 piston-engine aircraft of more than 20,000 pounds gross weight in operation throughout the world at present. In my opinion a good portion of these airplanes will change hands two or three times during the next five years. Small airlines now using the most obsolescent of piston-engine aircraft will upgrade their fleets. Major airlines will upgrade to jet powered aircraft. And many of the in-between airlines will step up to the more modern of today's piston-engine planes.

Another factor which may substantially influence the market for piston-engine aircraft over the next five years is the need for improved transportation facilities in many of the less developed areas of the world. Much of this need is for the movement of cargo, and as a result aircraft which are readily adaptable to cargo operations may be at some premium over those which are suited only to passenger operations.

There will be a considerable problem, however, in translating most of such needs for transportation facilities into an actual demand for aircraft. Basically, of course, the problem is one of financing. Since this is true, the Aircraft Exchange hopes to render a valuable service through its role of establishing future as well as current market values for aircraft and in this way helping to attract private and other capital into aircraft financing. One of the prime factors in any financing is the value of the collateral involved, and if financiers do not have a clear indication of the value of the collateral over a period of time, they find it extremely difficult to consider pay-out periods of three years or longer which are usually required to convert an obvious need for transportation into an active demand for planes.

This emphasizes our desire, which I have previously noted, to place increasing emphasis upon the futures aspect of the aircraft market. It is only when financiers have a reasonable forecast of future collateral values that they can participate in present aircraft financing on a non-speculative basis and hence at more reasonable financing charges.

For those who may not be fully acquainted with the operation of the Aircraft Exchange, I should perhaps point out that it is conducted similarly to the familiar stock and commodity exchanges. Its profits are rigidly limited. It receives quotations for the purchase, sale or lease of transport aircraft of over 20,000 pounds gross weight and matches high bids with low offers at the close of each weekly market. The Exchange represents neither the buyer nor the seller but maintains a completely impartial attitude towards both. Identity of those making bids and offers is kept secret until the closeness of a bid and an offer indicate that successful negotiations are a possibility.

In the two and a half months of its operation the Exchange has extended its airline membership to the point where its airline members own over two-thirds of the world's scheduled airline aircraft.

The most recent weekly market report reflects bids and offers totaling approximately $90 million at quoted prices. This includes only the high bids and low offers in each category and does not reflect an almost equivalent dollar amount which is not shown in the market report.

While the market is still predominantly a buyer's market, and while offers represent the heavy majority among the quotations, bids for 40 aircraft had come in as of this time, and five of these during the past week.

The first brief period of the Exchange's operation may not yet represent a true barometer of the actual market for transport aircraft ; however, the number of quotations listed has reached a sizeable level and is constantly growing, with a corresponding growth in the accuracy of our picture of the world-wide market for transport aircraft.

I should like to add here that, while the Exchange is still concerned principally with piston-engine planes, it has lately been drawn into the field of leasing new turbine-powered aircraft. This has come about as a result of current capital restrictions to airline expansion. Quotations have been received on new turboprop planes and other quotations are expected shortly on jet aircraft.

"Interavia" Essay Competition

Announcement No. 3

The preliminary review of the 235 manuscripts received from 28 different countries, referred to in Announcement No. 1 (*Interavia*, February 1959, p. 143), has now been completed. Papers on the air transport subject have been scrutinized by three independent readers and two members of *Interavia's* editorial staff, and those on the military subject by two independent readers and two members of the editorial staff.

The essays are now being submitted to the Panels of Adjudicators in preparation for selection of the prize-winners, which is due to be made during the Paris Air Show.

It is hoped that the names of the prize-winners can be published in the July issue of the Review.

Interavia S. A.

INTERNATIONAL MEETINGS AND CONFERENCES

May 6th-9th : American Helicopter Society, 15th Annual National Forum. Washington, D.C.

May 8th-9th : Annual Meeting of the Deutsche Gesellschaft für Raketentechnik und Raumfahrt. Munich.

May 10th-16th : Aviation Writers Association, 21st Annual Meeting and News Conference. Washington, D.C.

May 11th-15th : Joint Meeting of the AGARD Aeromedical Panel and Flight Test Techniques and Instrumentation Panel. Athens.

May 12th : IATA Financial Committee. Copenhagen.

May 12th : IATA Spring Composite and Joint Meeting of Traffic Conferences. To be decided.

May 12th : IATA Cost Committee. To be decided.

May 12th : IATA Charter Working Group. To be decided.

May 14th-16th : The Royal Canadian Air Force Association Annual Meeting. Montreal.

May 16th : Armed Forces Day. United States.

May 16th-31st : Austrian Gliding Championship, organized by the Austrian Aero Club. Zell am See, nr. Salzburg.

May 18th-29th : Series of Lectures on Astronautics, presented by the University of Rome with the cooperation of AGARD. Rome.

May 20th-22nd : The Society for Experimental Stress Analysis, 1959 National Spring Meeting. Washington, D.C.

May 20th-22nd : 2nd Jet Age Airport Conference, American Society of Civil Engineers. Houston, Texas.

May 21st : WGL's 3rd Ludwig Prandtl Memorial Lecture. Hanover.

May 21st-27th : International Transistor Exhibition and Convention. London.

May 25th-27th : Japanese Rocket Society, 1959 International Symposium on Rockets and Astronautics. Tokyo.

May 25th-27th : National Telemetering Conference on Investigation of Space, cosponsored by ARS, AIEE, IAS and ISA. Denver, Colorado.

May 26th-28th : IAS Regional Meeting on Supersonic Transports. San Diego, California.

May 28th-31st : Annual Conference of the Fédération Aéronautique Internationale. Moscow.

May 29th-31st : German Aero Club's 9th Air Rally. Berlin.

June : IATA Timetable Meeting. Paris.

June : International Congress of the Association pour l'Encouragement à la Recherche Aéronautique. Paris.

June 1st-6th : 11th Western Europe Airport Directors Conference. Brussels.

June 1st : IATA Executive Committee. Lac Ouimet.

June 2nd-5th : Annual General Meeting of the Max - Planck - Gesellschaft. Saarbrücken.

June 3rd-14th : Gesellschaft zur Förderung des Segelflugs, Gliding Contest. Wasserkuppe.

June 7th : Free Balloon Cup, organized by the Royal Netherlands Aero Club. Etten-Leur, nr. Rosendaal.

June 7th-9th : AGARD - Structures Fatigue "Full Scale Testing". Amsterdam.

June 8th-9th : Industry Missile and Space Conference, sponsored by Aero Club of Michigan. Detroit, Michigan.

New York Finance Notes

A New Round in the Air Transport Battle

BY SCOTT HERSHEY, NEW YORK

Transatlantic jet passengers are now paying $15 to $20 extra fare, and for jet flights coast-to-coast in the United States there is now a $10 surcharge, a situation which is in direct contradiction to the predictions of some experts not too long ago that jet aircraft on commercial routes would lead to lower-cost transportation.

The foreign and U.S. airlines still without jets—not those which have them—forced the transatlantic surcharge with not-too-veiled threats to break the international fare schedule and start a price-cutting war unless the faster jets were classified as premium service.

Another facet of the situation is the fact that the airline industry fears that if jet fares are cut now the bottom would drop out of the market on used piston planes in which every airline has millions invested. In addition, the financial situation of many airlines was somewhat shaky when they undertook the huge jet purchases with heavy outlays for equipment and ground facilities.

The extra fare on jet liners does not apply to the turboprop aircraft, and the lines operating this type of aircraft are making the most of it in splashy advertisements. The fight is one for the travelers' dollars, and never has airline advertising been more intriguing. El Al Israel Airlines points out that its *Britannia* planes are not subject to the transatlantic surcharge and that service is the best. Alitalia has been doing some striking and effective advertising.

The New York Times and The New York Herald Tribune abounded with airline advertising on the day this was written. KLM, for example, shows passengers in the cabin exchanging such remarks as "How come we don't have to stop at Gander ? The others do." His seat-mate answers : "Not us, KLM flies DC-7Cs."

Qantas proclaims that their 707 jets start July 30th, New York to London, and New York to Sydney via San Francisco, Honolulu and Fiji on July 31st.

BOAC proclaims "the only *daily* all de luxe and first-class to London—The Monarch flight." Pan American and TWA are both bidding strongly for passengers—transatlantic and, in the case of TWA, transcontinental. And National, which leased 707s from Pan Am, repeats and reiterates—First with jets in the U.S.

BOAC had announced round-the-world service with extension of its present London-San Francisco route across the Pacific to Hong Kong. Turboprop *Britannia* airliners which were to be used will link at Hong Kong and Tokyo with existing BOAC eastward flights from London to those points. The latter services are operated by *Comet* jetliners. BOAC inaugurated its London-San Francisco service in April 1957.

The Managing Director of BOAC has indicated that Britain does not intend to bargain with the United States over trans-Pacific air routes. His comment was made in connection with the protest lodged with the Civil Aeronautics Board over BOAC's getting rights to fly that route. The Managing Director, Basil Smallpeice, said the protest, made by Northwest Airlines, is "not justified" in frustrating BOAC's being given rights to fly that route. Northwest has been refused British permission to extend its routes to Hong Kong via Tokyo and Taipei.

On the other side of the world British and American lines were faced with the possibility of powerful competition in a reported move which is attracting interest in financial circles. Investors in airline securities were watching developments of a report that the five airlines operating in "Little Europe" are mapping plans to merge into a powerful European airline that would offer vigorous world-wide competition to Pan American, BOAC, TWA and others. (See article on Europair elsewhere in this issue.)

The potentials of such a combination are obvious and the competitive possibilities have the greatest of significance in the air transport industry particularly at a time when the changeover to jet equipment is being made and the scramble for air passenger revenues to meet the heavy expenses of the changeover is at its height.

It was indicated that if the merger comes about the six nations of Little Europe—West Germany, France, Italy, Belgium, Holland and Luxembourg—would operate as a single country so far as air transportation is concerned. Thus, it would be possible that airlines from outside countries might not be able to haul local passengers within the six nations. Pan American, for example, might be barred from carrying passengers from Paris to Rome or Munich.

Back of the idea, it was said, is a merged company along the lines of SAS, the Scandinavian airline which is a merged operation bringing together companies from Norway, Denmark and Sweden and enabling them to have a far stronger operation than any one of them could afford individually.

Manwhile, the problem of disposing of piston-powered aircraft to make way for the jets continues. American Airlines, first U.S. jet transcontinental operator, is moving fast in this connection. American has contracted with Frederick B. Ayer & Associates for sales of forty-five Douglas DC-6 piston-engined planes in a transaction involving $30,000,000. With the current transaction, American has made arrangements to sell 114 of its piston planes or more than 50 percent of the fleet in operation eighteen months ago.

Mr. Ayer said a result of the agreement with American will be the opening of permanent Ayer sales offices in Europe and Latin America.

At the same time, Aircraft Exchange has announced the appointment of Air Service of Oslo as the representative of the Exchange throughout Norway.

Eastern Air Lines, commenting on the progress of its $185,000,000 re-equipment program, reported cash payments of $70,000,000 will be made this year on delivery of the remaining thirty Lockheed *Electra* turboprop transports and the first Douglas DC-8 straight jet.

Increased fares, at least those permitted thus far, do not seem to provide all the answers to financing jet equipment ; Eastern reported that interim fare increases granted last year by the CAB pending conclusion of its general passenger fare investigation, brought Eastern $11,930,000 additional revenues, or less than half of what the company considers equitable.

While the American jet carrier operators have been basking in the glories of their Boeing 707 equipment, quite a different note comes from Boeing. William M. Allen, Boeing President, reported that "with development and production costs on the commercial jet program exceeding the amounts previously estimated, a substantial loss is being incurred on the model 707 airplanes delivered or on order."

Will Daddy be home for my birthday?

For this little chap, tomorrow is a day with a difference. A red-letter date that will add one more candle to the cake. The big question is, can Daddy be back in time ? The answer ? Yes, he can—easily! Fathers often have to travel around Europe. But these days they need waste no time getting home. BEA brings all the continental capitals and commercial centres within a few hours of London. And links London with the rest of Britain, too. In fact, the BEA network is the most comprehensive in Europe. It is served by the largest Viscount fleet in the world and it provides a greater variety and frequency of flights over the Continent than any other airline. So if you are anxious to go abroad, or eager to get home—fly BEA—the airline that has made big business of air-travel in Europe.

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1950: 2000 m
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1957: 2600 m
23
1960: 3900 m
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NAPIER **GAS TURBINES**

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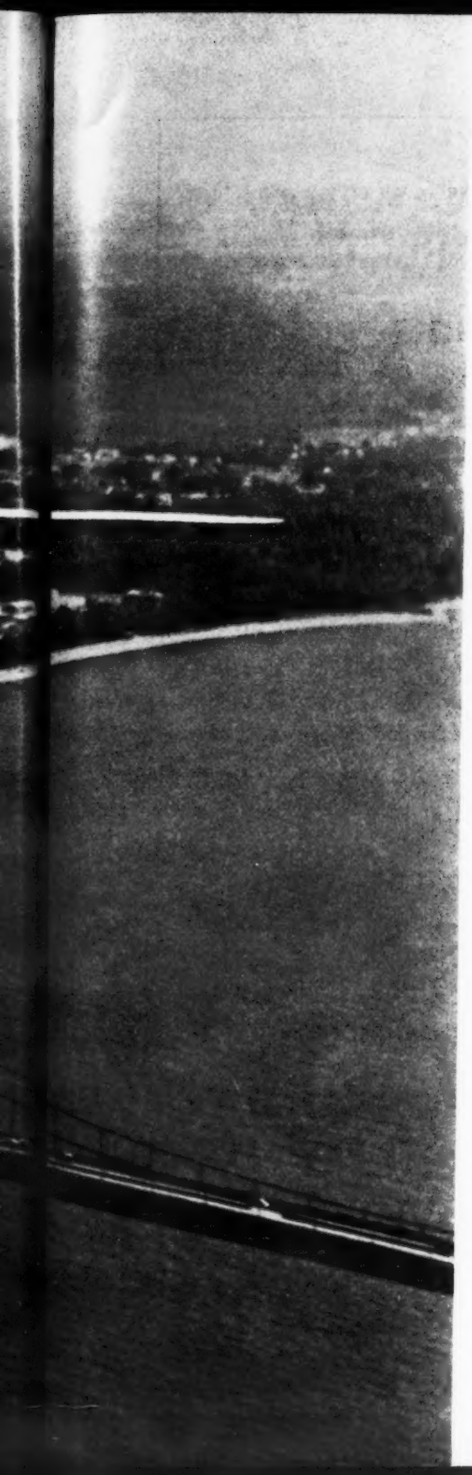
The four-ton H-16, first in Vertol's series of turbine-powered helicopters, flown in 1955.

The H-21 D research aircraft equipped with two GE T-58 turbo-shaft engines, flown in 1957.

The Vertol 105 with two Lycoming T-53 engines used in the test programs, flown in 1957.



Why Vertol leads in turbine helicopter design and development

Steady progress in technology has advanced this versatile air vehicle, the helicopter, to the threshold of a new era of usefulness. It is the era of the turbine-powered transport helicopter designed for improved battlefield mobility and logistical support of combat elements and missile systems, and for all-weather, day-night operations in military or commercial service.

Vertol has been and is today at the forefront in progress toward this new achievement. Among the first to recognize that turbine power would vastly improve performance, capacity and versatility, Vertol also is a leader in research and development on new designs incorporating these powerplants.

The result of many years of work in this field is the Vertol 107, first member of an entirely new generation of multi-turbine helicopters destined to play vital roles in short-range transportation throughout the world. It is now being produced for the U. S. Army as the YHC-1A. The "107" can be adapted to an almost limitless variety of functions without altering basic design. Its built-in growth potentiality has already resulted in a decision by the U. S. Military to procure a larger, more powerful version of the 107 type from Vertol. This growth also assures a steady future progression of helicopters of greater performance, load-carrying ability and versatility.

In 1958 the Vertol 76, powered by the Lycoming T-53 was the world's first successful tilt-wing VTOL.

VERTOL Aircraft Corporation

MORTON, PENNSYLVANIA

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Smart people fly

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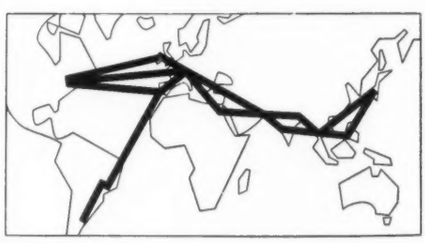

Your travel agent will tell you: The fares are all the same: it's the service that's different

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TURIN

September 24th to October 4th, 1959

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MACHINE TOOLS

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6th European Plastics Show
11th International Plastics Congress
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11th International Cinematographical Congress
11th International Film Week
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3rd Competitive Exhibition of Inventions and Industrial Progress
International Meeting of the Technical, Scientific and Periodical Press

Foreign agents

PARIS — Italian Chamber of Commerce in Paris, 134, rue du Faubourg-St.-Honoré — Tel. ELYsées 46.27, BALzac 40.88

FRANKFURT/MAIN — Italian Chamber of Commerce for Germany, Feldbergstrasse 24 — Tel. 774.747 - 774.767

BRUSSELS — Belgo-Italian Chamber of Commerce, rue du Midi 61 — Tel. 12.96.31

AMSTERDAM — J. Leonard Lang, Stadhouderskade 114 — Tel. 719.744

GENEVA — Pondil S.A., rue de la Tour-de-l'Ile 1 — Tel. 25 62 34

WEMBLEY (Middx) — Fiat England Ltd., Water Road — Tel. PERivale 5651

Champion announces opening of...

World's most modern research and engineering center for spark plugs and turbojet engine igniters

This new, Champion-developed Jet Igniter Tester can duplicate virtually any combination of igniter firing cycles. With it, Champion engineers run rigorous endurance tests that compress years of flight experience into a few days ... resulting in evergreater ignition dependability for Champion users.

This new Jet Igniter Tester—developed by Champion engineers—is another example of how Champion's new Center benefits you...

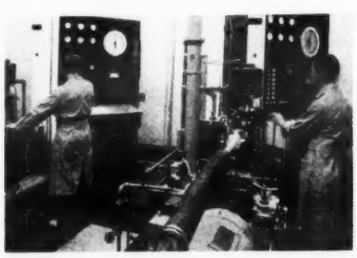
The Champion Spark Plug Company has announced the official opening of the world's largest and most modern facilities for spark plug and jet igniter development—the new Champion Research and Engineering Center at Toledo, Ohio, U.S.A.

What do these new facilities mean to you ? They mean that, tomorrow as well as today, the name CHAMPION is your assurance of the finest and most dependable spark plug and igniter performance possible. They also mean that Champion is placing even more emphasis than before on its constant efforts to improve what are already the world's finest spark plugs and jet igniters.

Champion's new Jet Igniter Testers are an example. Champion already has the world's largest fund of jet igniter experience, but Champion engineers developed these new units so that Champion could learn even more about solving the complex ignition problems of the jet age.

Champion's new research and engineering facilities are one more reason why—when you order spark plugs or jet igniters for your aircraft—you should always specify CHAMPION.

Here research experts study basic problems such as temperature ranges, fouling, and preignition limits to develop materials, alloys and designs that will improve performance even more.



Laboratory testing of aviation spark plugs is done in these two 17.6—cubic inch rating engines. These specially designed test engines can be precisely controlled and adjusted to produce specific powers higher than the most severe aviation engine operating conditions.

World's favorite on land, on sea, and in the air...

CHAMPION

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Experience speaks for

SAAB SAFIR

Three countries re-order

Forty-two new SAFIR trainers have recently been ordered by three countries from SAAB which has supplied this proven trainer to eighteen countries. An immediately preceding order for twenty aircraft for the Finnish Air Force has just been completed. These latest orders have been placed by Holland, Ethiopia, and Sweden, countries with experience of this Swedish aircraft — experience that leads to re-ordering.

The latest order placed by the Imperial Ethiopian Air Force — for ten aircraft — is the seventh received by SAAB from this customer. The eighteen new 91 D* SAFIRs ordered by Holland are intended for Rijksluchtvaartschool, the Government Civil Flying Training School, as trainers for future KLM pilots.

The Royal Swedish Air Force is adding fourteen aircraft to its current fleet of eighty-five SAFIRs.

** SAAB 91D SAFIR, with its new, lighter 4-cylinder Lycoming 0-360 engine, has a constant-speed propeller and a generator which can supply more radio equipment and electrical extras. The lighter SAAB 91 D SAFIR has a bigger useful load.*

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AEROPLAN AKTIEBOLAGET
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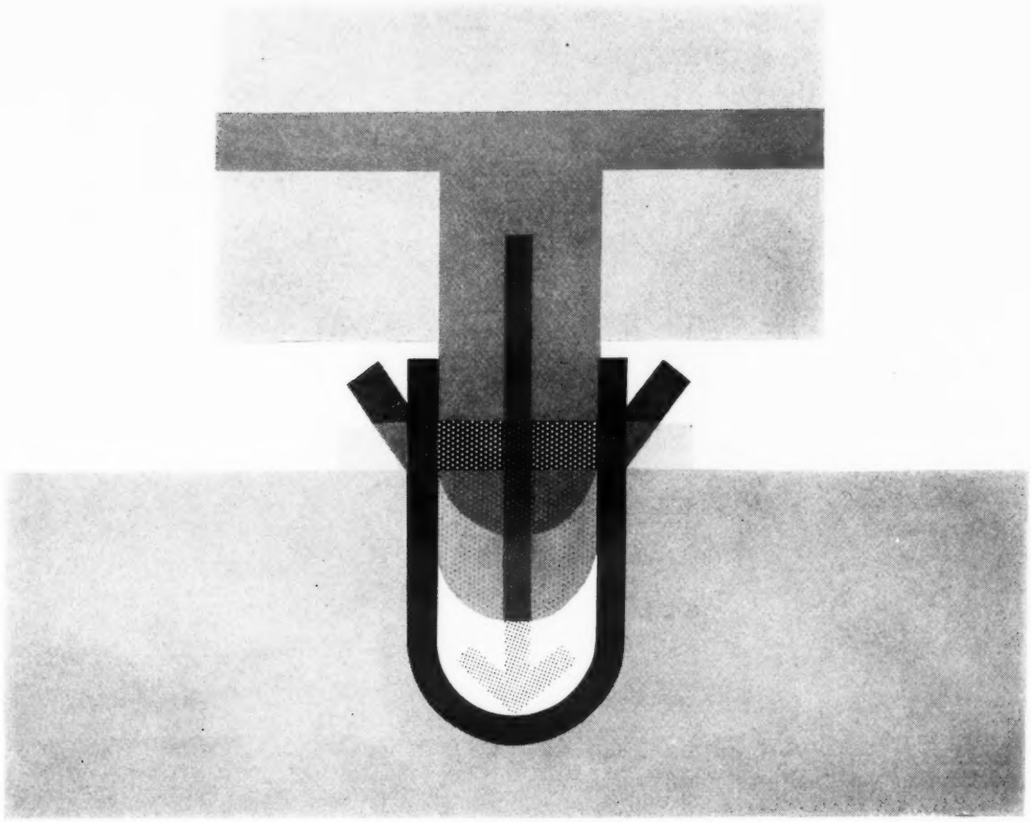
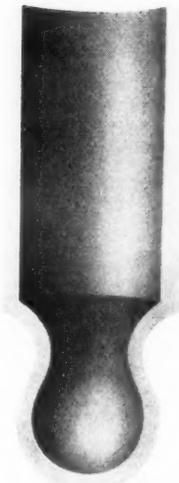
SAAB

A new way with Pistons





Wilmot Breeden have recently developed a method of cold working (drawing and rolling) shells to close tolerances and high surface finishes. Applied to the quantity production of precision components, formerly machined from bar or forgings, it provides striking economies and high output rates.

If you have an application for this new method we should be pleased to investigate and advise.

The piston illustrated here has a diameter of 1.4". It is cold drawn from sheet steel, and the neck and spherical end are produced by rolling. Surface hardness is 750 VPN. The benefits from this process are a substantial saving in materials and manufacturing time, and freedom for the designer to secure the maximum effectiveness and utilisation of material, through the maintenance of grain flow and structure.

The illustration is by courtesy of Joseph Lucas (Hydraulic and Combustion Equipment) Ltd.

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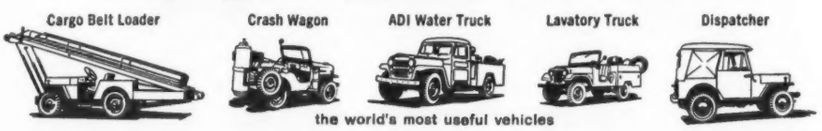

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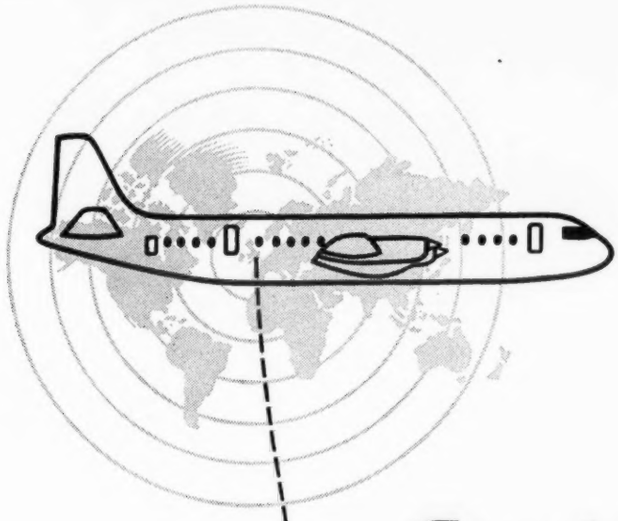

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* SR. 35 GLIDE PATH RECEIVER. 20 channels in the band 329.3 to 335 Mc/s.
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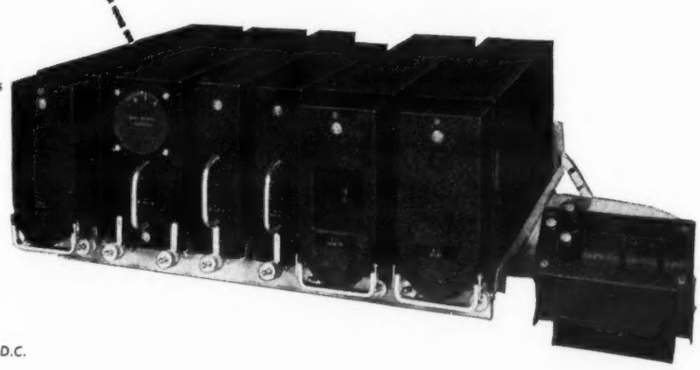
Operates from 115 Volts, 400 c/s, single phase A.C. or 28 Volts D.C.



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The Allison-powered Lockheed Electra is now joining the jet-age fleets of 15 airlines. It has proved that, in addition to its long-range capabilities, it brings jet-age superiority with economy on short to medium ranges which make up more than 75% of all travel by air.

The greater efficiency of jet-plus-prop provides outstanding take-off, climb, cruise and landing performance. The reverse thrust produced by the Aeroproducts Turbo-Propeller assures positive stops on short, wet or icy runways. Low vibration and sound levels please the passenger as well as the airport neighbour.

The Allison Model 501 prop-jet engine, with its matched Aeroproducts Turbo-Propeller provides a GM jet-power team with performance far beyond any prop-jet powerplant now in commercial service.

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GM JET POWER

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The Super Tiger is a high altitude fighter or a low-level attack bomber. The ease with which a pilot can make the transition to the Tiger series eliminates the costly need for two-seat trainers. Designed for use on aircraft carriers, the Super Tiger can operate from small hidden airstrips without the use of artificial flight augmentation.

Per maintenance hour, U. S. Navy F11F-1 Tigers have flown twice as many hours as any other type of jet aircraft presently on Naval operations. With these same maintenance-free features inherent in the higher performance Super Tiger, it is literally two aircraft for the price of one.

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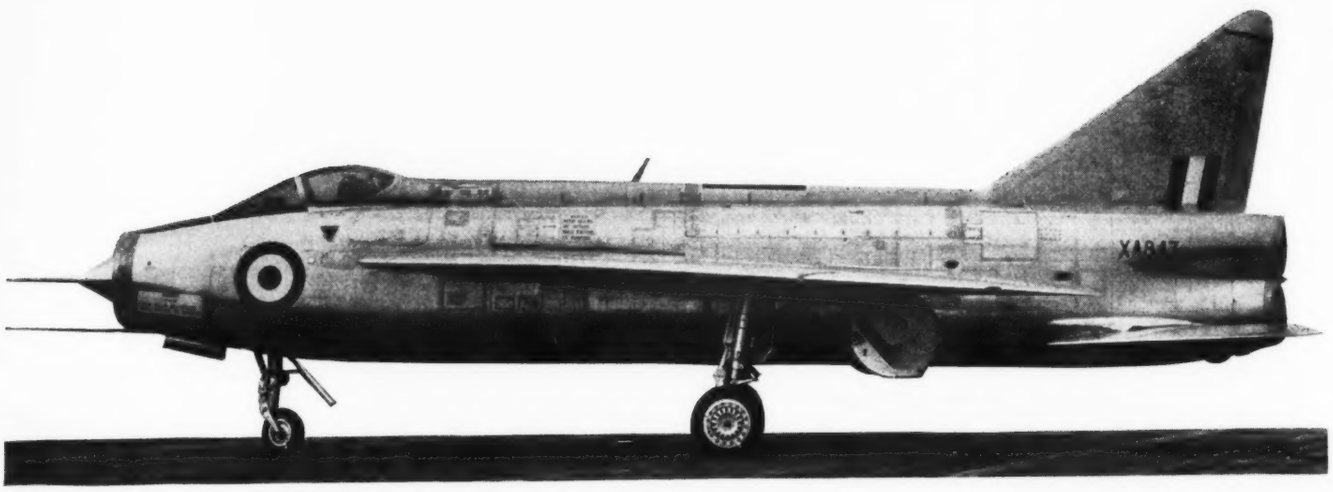
The ENGLISH ELECTRIC LIGHTNING provides frontline defence at all times. It is completely equipped with navigational, radar and automatic aids. Whatever the weather, in daylight or darkness, the pilot can make full and effective use of the LIGHTNING's stupendous performance.



...THE *LIGHTNING*

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THE **ENGLISH ELECTRIC** COMPANY LIMITED · MARCONI HOUSE · STRAND · WC2

Towards the Golden Age in Air Transport?

The passenger entering the transit lounge at Geneva's Cointrin airport in the early morning hours one day last March was met with a strange sight: in the dim light he could make out forms rolled in blankets—recognizable as women only from their heads and feet—stretched out on the settees, while their male companions dozed fitfully in the nearby armchairs . . . He counted between fifty and sixty figures. Somehow the whole scene reminded him of pictures of the old steerage-class passengers. What had happened?

Simply that on making its transit call late the previous evening a long-distance aircraft had been found to have a small technical defect which had to be repaired. When the repair—as can easily happen—took much longer than expected, the whole airport personnel, reinforced by Swissair staff, feverishly began telephoning around for accommodation for the passengers from the stranded aircraft. But, as bad luck would have it, Geneva's International Motor Show had opened its doors that very day, and there was not a bed—or even a bathtub—to be had within a radius of forty miles.

The moral of the story is clear: unless something is done soon to provide additional hotel accommodation in the countless major cities in both the Old and the New World to which the jet transports will be bringing legions of passengers within the coming months . . . the airlines can pack up. The world's tourist flow will move into other channels on whose banks there happens to be sufficient accommodation. So much by way of introduction.

*

Incidentally, do you know what *IHC* stands for? As an attentive reader you will certainly have seen an article in the October, 1957, issue of *Interavia* entitled "Air Travellers in Search of a Hotel": ". . . During the summer season there is already a marked shortage of hotel accommodation in London, Paris, Rome and most other European cities, and in 1960, when jet aircraft are introduced into commercial service, there will be a need for many thousands of extra beds. What is even more serious is that the hotel industry is at present paying very little attention to air travellers. Whereas most of New York's larger hotels send representatives to meet the big trans-Atlantic liners, nobody bothers very much about the 2,000 travellers who arrive every day by air. The situation is scarcely different in Paris, London, Rome or Geneva . . ." What then is the *IHC?* It is the abbreviation of a subsidiary, the *Intercontinental Hotels Corporation*, founded by Pan American World Airways in 1946. By 1957 the Corporation had already built fourteen new hotels with a total of some 4,000 rooms, and has continued to be very active since then. A few weeks ago its President Peter Grimm visited Geneva to explain to the Swiss authorities what he understands by hotel design. And new IHC hotels are nearing completion in Vienna and elsewhere.

Hats off to Juan T. Trippe, President of Pan American World Airways, for his far-sightedness: not only has he let his jet aircraft loose on the customers, but wherever possible he keeps passengers under his wing even on the ground and already has a respectable income from the hotel business to round off his air travel business. A tip to his colleagues in Europe, Asia and Africa: don't leave your passengers to sleep under bridges!

*

While on the subject of abbreviations, do you know what *GMRD* is? So far it has not been discussed in *Interavia's* pages, but this omission must now be made good, since indirectly it too provides PAA with an additional source of income. GMRD stands for the *Guided Missiles Range Division* of Pan American. PAA's slogan is "*First* on the Atlantic—*first* on the Pacific—*first* in Latin America—*first* round the world". And of course first in the guided missiles business. Not to give a lift to passengers so much as to the U.S. armed forces. One so often reads about missile launchings from Cape Canaveral, Florida, some of them successful, others less so, but how many readers know that this missile centre and many others in 79 countries on 6 continents are administered and operated by Pan American World Airways? Some 5,000 of PAA's staff are available for these duties. Although PAA is not officially the U.S. Government's "chosen instrument", it is certainly not on bad terms with the Government, as witness the GMRD. At the time when the armed services found it impossible to agree among themselves as to who should administer the bases, PAA stepped in. It not only performs necessary duties at the actual bases, but also provides transport for service members and cargo, all of which is in a sense a by-product of its airline activities. Admittedly, it is assisted in the overall work by Radio Corporation of America, but the latter in any case is not concerned with transport.

*

A third question: what is TAP? In this case not the abbreviation for a Portuguese airline, but for PAA's *Technical Assistance Program.* This youngest branch of the business will also doubtless bear fruits. Just as there are under-developed countries, so there are in some lands under-developed airline industries. These are helped by PAA's Technical Assistance Program, which was organized under the Congress's 1954 plans for a "program of self-help and mutual cooperation among free nations designed to develop their economic and social well-being". Present beneficiaries of the program are the Turkish airline Türk Hava Yollari, Pakistan International Airlines, Thai Airways Company Ltd. and Ariana Afghan Airlines. When these airlines become self-supporting one day, they will owe much to the timely help provided by Mr. Trippe.

*

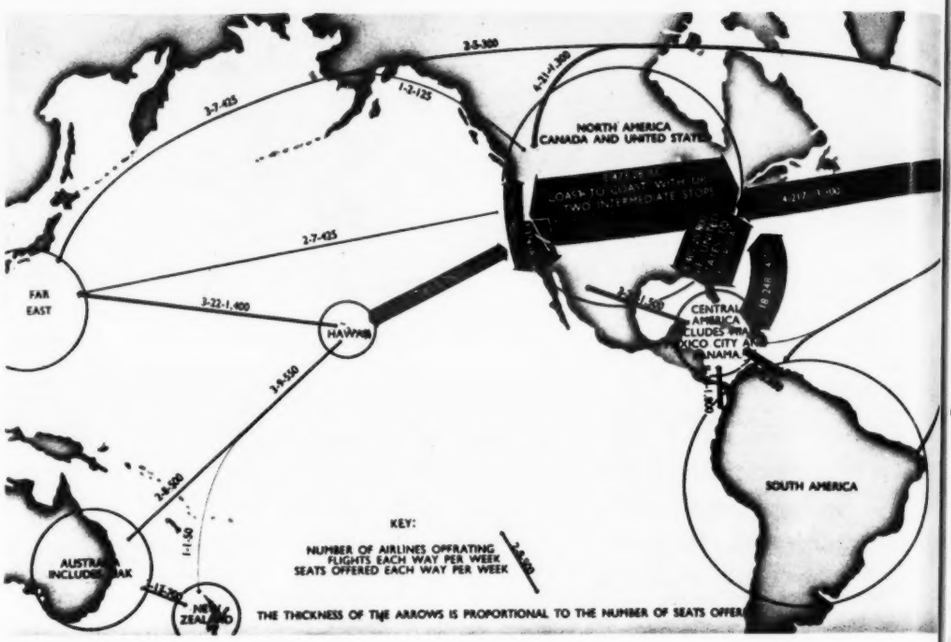
Jet aircraft in airline service . . . passengers by their hundreds . . . but no hotel rooms.

These questions have been singled out for comment in order to explain how it was that the President of PAA could afford a few years ago to commit his company with a stroke of the pen to an expenditure of several hundred million dollars, when he placed a large-scale order for jet aircraft. PAA has subsidiary incomes which are fast taking on major proportions. Theoretically it could run air services as a hobby, but in practice it takes this side of its activities absolutely seriously — as its competitors well know.

Meanwhile, recent developments on this side of the Big Pond suggest that Mr. Trippe's European colleagues are also beginning to learn the ropes ...

In the light of IATA's rate policy to date, what has been achieved seems little short of miraculous. However that may be, a recent International Air Transport Association Traffic Conference in Paris arrived at the almost revolutionary decision to *introduce low-fare individual inclusive tours by scheduled aircraft in the European and Mediterranean region from April 1st, 1959.* Since then most of the European airlines have been feverishly busy picking out the most attractive resorts for their tourists, the best and most reasonable hotels, the finest restaurants, the most expert guides and advisers at intermediate points of call or destinations. Admittedly in this they are making life more difficult for the charter companies, but some of the latter at least have deserved their fate. There was, for example, the recent case of a party of German tourists left to the mercies of the local authorities and their Consul in Teneriffe because a Hamburg air tour operator, after cashing in the charges for the tour and transporting the party to Teneriffe, found himself without the means to get them back again. If Lufthansa and Air France, Swissair and SAS, Sabena and KLM and the others protect tourists under their flags, then the air traveller will be in no danger of meeting with similar adventures, and the new line of business for the scheduled operators will probably pay good dividends.

Just imagine, in future a tourist will get not only the normal 10 percent reduction on his round ticket, but also another 20 to 30 percent on the actual transport costs if he books an inclusive tour. He will travel by regular airliner operating on a fixed schedule and can choose his dates to suit himself. He can book his vacation tour, at a fixed price, at any IATA travel agency, use any aircraft which serves his destination and has room for him, and break his journey at any intermediate point of call. The only restriction is that the return flight must be made between the twelfth and the 23rd days. He can choose his resort anywhere in Europe, the Near and Middle East, North Africa, or even the United States, Central or South America. Combined trips by air, boat and rail can also be organized. He can travel first or tourist class, just as he fancies or as his pocket book allows.



Lufthansa advertisement for individual inclusive tours: Planned by your IATA travel agency, low-cost individual inclusive tours on Lufthansa's regular services.

*

The present issue is devoted to the early results and immediate prospects of jet services, and it cannot be argued that all this has nothing to do with jet transport. What has been discussed above either has made jet services possible or is their direct consequence.

Some of the more conservative airlines may have felt concerned about how they were to fill their aircraft and cope with the surplus seating capacity offered by the increasing number of turbine aircraft coming into service alongside the existing propeller transports. Are there not already signs of a surfeit of aircraft; are not prices of used piston-engine aircraft, most of them still not fully depreciated, falling every month? Instead of sacrificing their existing fleets at give-away prices, airline managements have at last found a way to attract *really new categories of air travellers.*

The *next step* must be the *provision of more hotels* to accommodate these increasing numbers of tourists and business travellers. According to a report in our hands, 87 new hotels with 30,015 rooms were built in the United States in 1958, at a total cost of $ 701,288,000. In addition 19 existing American hotels invested some $ 40,000,000 in adding 2,072 new rooms and improving their facilities. All this in a year when the country was experiencing very definite recession conditions, at any rate during the early months. If in this recession year the revenue of the American hotel business fell by only 2 percent compared with 1957, and reached the respectable figure of $ 2,677,000,000, it is clear that jet services will bring a new era of prosperity to the hotel owner.

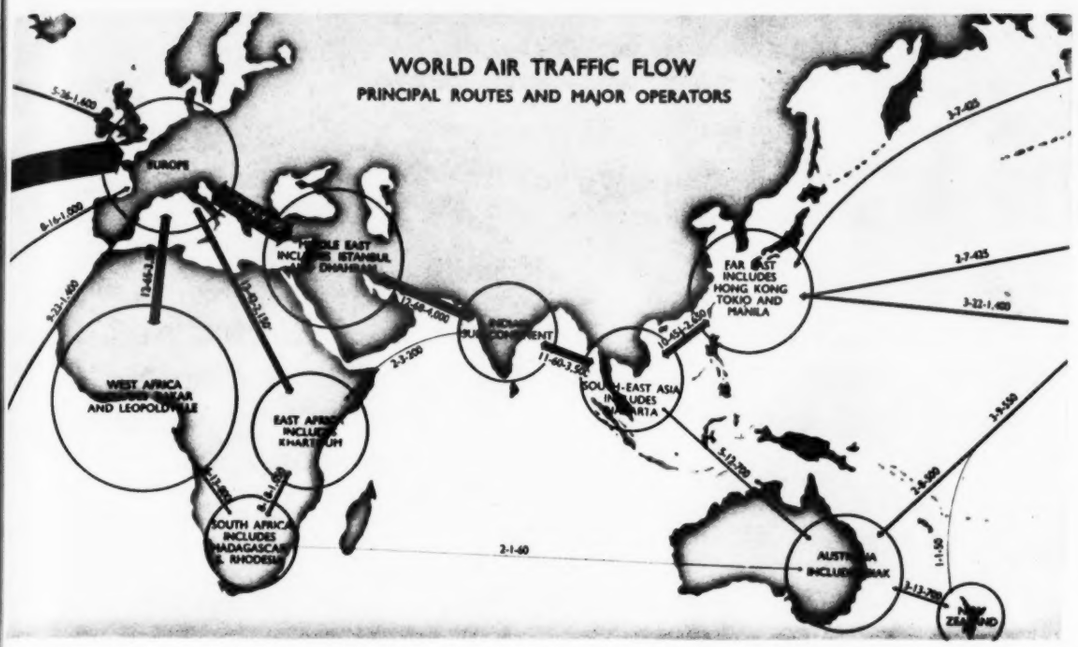
*

Both the initiated and the layman have already written reams on the subject of the jet age. Nevertheless *Interavia* could not neglect to report on the first results achieved. All of which makes encouraging reading.

Strangely enough, the correspondents who have sent in such copious details of the first operations by Pan American World Airways, American Airlines and other airlines have all forgotten the *key figure* in international air transport. None of them have quoted the *air hostess*, which is not very gallant of them and constitutes an omission which must certainly be made good. American Airlines' chief stewardess recently commented with satisfaction that the future generation of hostesses can be taller and broader, as the new jet aircraft are higher and wider: "Hips can't be too large, for instance." This ought to make a lot of things easier . . .

And as we were conducting our "hearings" Esmeralda, our Favorite Hostess, also insisted on having her say. This somewhat fresh young woman does not seem to be too impressed by jet services; all she's looking forward to is the *Golden Age in air transport.* What she means by this will be seen elsewhere in this issue. Without wishing to take sides either with or against her, we will content ourselves with saying that perhaps the jets will bring us closer to this Golden Age.

EEH



The main flow of long-range air traffic, which will also be followed by the big jets, moves in a band across the Pacific to the United States, the Atlantic, the Middle East to southeast Asia and the Far East. Other busy routes from the south (South America and Africa) flow into the main band.
(Courtesy de Havilland)

Jet Route Reconnaissance

By Derek Wood, Interavia's London Editor

London to Tokyo—seven thousand and forty-nine miles, states a well-known reference book. It sounds simple put like that, but to the operator it means flying over 15 different countries, stopping at anything up to eight airports and coping with many different languages, changing facilities, and every kind of weather including the Monsoon.

The Middle and Far East are alive with development programmes. New dams, power stations, steelworks, roads and railways must be built if the relatively new nations are to industrialize their economies. Money is the key, and suddenly in the midst of all this, governments are faced with the jet age calling for larger airport buildings, longer runways, improved air traffic control and more navigational aids.

An opportunity to find out for ourselves what the impact of the jet will be on this long and complex network came recently when BOAC invited us to fly on "CGF 820", a de Havilland *Comet 4* proving flight to Tokyo, prior to the introduction of the first Far Eastern jet service, which took place on April 1st.

Teheran has one of the most modern terminal buildings in the Middle East, completed in 1958.

A check on cholera and yellow fever inoculations, two visas and a bottle of Chlorodin in case the local waters were unkind to a pure Western stomach, and I was set to go. At London Airport on a surprisingly sunny day, a handful of journalists and BOAC, de Havilland, Rolls-Royce and Lucas technicians settled in the rear, tourist section, of *Comet 4* G-APDC, while the forward, first class cabin was filled with training crews.

For this proving/training flight, the operating crew numbered nine, including two stewards and a stewardess, and was commanded by Captain R. C. Alabaster, a veteran *Comet* flier with over 2,000 hours on *Comets 1,* 2E and 4.

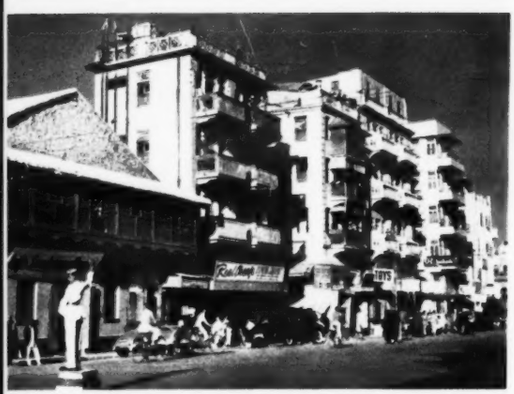
Crew under training comprised four captains, four first officers, five engineer officers, three navigating officers, seven stewards, and three stewardesses—quite a galaxy.

With lap straps fastened and barley sugar crunching, we prepared for the first leg of our long sortie. Lined up at the end of the runway, the Rolls-Royce *Avons* roared into full song, and the *Comet* demonstrated its extraordinary rate of climb on take-off—a feature which was to be manifest throughout the trip. After grinding up from so many runways on a long full-bore climb in piston-engined types, the feeling of power on the *Comet* was uncanny, especially when the pilot always throt-

The *Comet* crew on the route proving flight to the Far East. Far right, Captain R. C. Alabaster. In civilian clothes J. R. Allison, BOAC Manager in Pakistan.

The *Comet 4* flight deck.

Flying over Iran.



Karachi is a major city with well regulated traffic, good shops and modern dwellings.

tled back on the inboards just after take-off, and the mild roar receded to a hum. Throughout the journey the lack of noise and vibration reduced fatigue, and it will be a major ticket selling point.

Our route lay across France, and in the upper air we gently cruised at 37,000 ft. at 410 knots. Plenty of nav. aids to help jets on their way, but perennial problems affecting *Comets,* 707s and the like in Europe are constant military air exercises which limit routes and heights. A *Comet* 4,000 ft. below its optimum burns 1,000 kg more fuel on a 5-hour sector. This is the equivalent of 10 passengers plus baggage! Coordinated control over Europe and a network of straight jet airways are now crying needs if airlines are to make profits.

After just over an hour's flying, we were over the Alps and heading into Zurich where, judging by the reception, jets are still a novelty. A brief stop for fuel and we taxied out again once more for take-off. Half Zurich seemed to have turned out to see us away, and the fence round the perimeter was packed—even a cook leaned out of a hut in all his finery and waved a frying pan in salute.

Once more on climb with darkness coming on, the Captain came up against the situation where controllers are still unused to jets, their heights and speeds. Italian control made four changes of acceptance in a few minutes, finally routing the aircraft via Florence instead of Chioggia and Falconara as originally planned. To ease the controllers' problem, the *Comet's* call-sign throughout was "*Jet* Speedbird eight two zero".

Below us in the darkness passed the Pindus mountains and 2 hours 52 minutes after leaving Zurich 1,150 miles away, we were overhead Istanbul. On the let-down, I laboriously filled in a massive entry form. I need not have wasted my time, as when I handed it to immigration in the small crowded arrivals room, it was promptly torn up and I was handed another which was a different shape but asked the same routine information on if one got married, and why one was born, etc. Forms, and transit passenger facilities where there is only a night stop need improvement right down the route—some of the officials would have been termed speedy when Stephenson first ran his *Rocket* engine, but times have changed a little. The picture of two loaded 707s arriving simultaneously at some airports is too unpleasant to think of.

Having cleared customs, I prepared for the long bus ride into Istanbul, but was delighted to find that we had only 3 km to go, to a brand new hotel, the Cinar, with every modern convenience. Only recently completed, the Cinar looks out onto the sea of Marmora, and is something that most airports are in desperate need of.

Awakening to sunlight and the sound of waves lapping, we enjoyed a leisurely breakfast before driving to the airport. Streams of local people crowded up the gangway to examine the Comet's interior.

Finally, at 10.15 a.m. we were airborne and heading East for Teheran, using non-directional beacons and radio ranges across the rugged country until Teheran VOR came in. It was clear that the greater part of the Middle East needs improved aids and a great many more VORs, the latter being "programmed" but not yet installed. Many of the airways have uneconomical dog-legs which need straightening, and there are too many wide areas of prohibited air space which hinder clearing up the routes. Several airports need either drastic enlargement or resiting.

Plans have existed for a long time, but implementation is another story. For instance a completely new Jedda Flight Information Region is scheduled for Saudi Arabia, but as yet no equipment has been purchased or installed.

Communications too are poor overall, particularly between control areas, and direct speech circuits are a must. Troposcan techniques with new aerials and increased transmitter power, now on test at Hong Kong, would give increased ranges of up to 340 miles at 17,000 ft.

On the jets, delays on turn-round will be unacceptable, but unless station-to-station communications improve, they will occur. In the Middle East, load, passenger handling and general traffic signals can take anything up to 6 hours.

Any improvement in radio and electronics will call for many more skilled engineers than are at present available and more aircraft equipped with accurate calibration instruments, for aids are useless unless they are frequently checked.

Meditation on these subjects was interrupted by the Captain announcing that Mount Ararat was coming up on the port side, unfortunately without any sign of Noah's Ark.

At 12.30 it was further reported that Teheran was below minima with 8/8 cloud at 600 ft., and we prepared to over-fly and go on to Karachi. Fifteen minutes after passing Teheran, however, the call came through that the weather was lifting and we turned back to do two practice let-downs before landing.

Teheran possesses one of the most modern and spacious airport buildings in the Middle East which was only completed in 1958. As usual, runways were quite adequate for the *Comet,* but needed several thousand feet to meet ICAO recommendations for the maximum weights expected on the 707 and DC-8.

An Indian family examines our *Comet* with close interest at New Delhi airport.

They can't impress *me* with their jet aircraft...

Rangoon airport.

After a conducted tour of the airport buildings, we re-embarked and were soon at 35,000 ft. en route for Delhi. This sector is particularly in need of improved aids and VOR to replace the few beacons at present available. One NDB was not functioning and another too weak to give a reliable bearing. In the end, the navigator had to resort to astro, and while this was being worked upon, Delhi advised that fog was closing in.

Further complications were reported on hotels, where a visit of the Duke of Edinburgh, a Science Congress and delayed aircraft had made inroads into the available accommodation.

Accordingly we set course for Karachi, having previously been put further east by a strong tailwind.

Karachi Airport is well equipped and has a modern terminal, but even here runway extensions are in progress, and a 10,500 ft. runway should be in use by the end of 1959.

Because of further fog risks and the accommodation problem at Delhi, it was decided we should spend two nights at Karachi. Hotel acccmmodation in the city is not easy, and we stayed at the Air France rest house on the airport perimeter, which, along with similar institutions run by KLM and BOAC, solves the transit crew problems, but is unlikely to be able to cope with stranded passenger loads from a big jet or jets.

Martial law had spring cleaned Karachi in a remarkable way, clearing the streets and improving shops, etc. I was not a little surprised to find the bus driver sticking firmly to the 25 m.p.h. speed limit as we toured the city. His reason was simple: "Well Sahib, would you like seven years rigorous detention?"

Seated on the veranda of the BOAC rest house, Mr. Allison the Corporation's local manager discussed the route and traffic. Like India, Pakistan has strict currency restrictions, which mean that the foreign community provides the main customers—technical advisors, engineering teams, etc.

Mr. Allison stressed that frequency was particularly important on the Far Eastern route. In his opinion, jets needed to be of moderate size with higher frequency, not much larger with lower frequency. In his opinion, the *Comet* was just about the right size.

Comet Proving Flight Schedules

Leg	Cruise altitude (ft.)	Cruise T.A.S. (knots)	Time on course to overhead	Take-off weight (kg)	Landing weight (kg)	Take-off fuel (kg)	En-route navigation methods	Total distance (n. miles)
London—Zurich	37,000	410	1 hr. 15 min	62,400	52,000	21,700	VOR, NDB, R/R	460
Zurich—Istanbul	34,500 to 38,500	410	2 hrs. 52 min	64,700	52,000	23,950	VOR, NDB, R/R	1,159
Istanbul—Teheran	36,000 to 38,500	408	2 hrs. 47 min	65,290	49,380	24,550	NDB, R/R and Teheran VOR	1,099
Teheran—Karachi	35,500 to 38,000	410	3 hrs. 55 min *	66,500	50,050	25,000	NDB, astro R/R, VOR, VDF	about 1,200
Karachi—New Delhi	39,000	420	1 hr. 20 min	56,500	48,100	16,000	VOR, NDB, R/R	593
New Delhi—Calcutta	38,000	420	1 hr. 36 min	56,700	51,000	16,000	NDB and R/R	712
Calcutta—Rangoon	36,000	420	1 hr. 23 min	60,400	52,500	20,000	NDB, R/R	557
Rangoon—Bangkok	35,500	410	0 hr. 50 min	52,500	46,900	12,500	NDB, VOR	321
Bangkok—Hong Kong	35,000 to 37,500	415	2 hrs. 2 min	65,500	—	25,000	NDB, VOR	1,026
Diversion to Manila	39,000	—	4 hrs. 45 min *	—	—	—	LORAN	Hong Kong—Manila about 620
Manila—Hong Kong	37,000 to 39,000	410	1 hr. 50 min	60,500	52,500	20,000	VOR, NDB, LORAN	607
Hong Kong—Tokyo	35,000	415	3 hrs. 30 min	67,000	52,000	26,500	VOR, NDB, LORAN	1,710

* Chock-to-chock times.

River market in Bangkok.

Hong Kong, the last European settlement in China.

The *Comet 4* experiences no difficulty in approaching Hong Kong among the rocky cliffs.

After two nights on hard cane beds, awakened by the constant hooting of trains in the station outside, I was glad to relax in the *Comet's* Microcell seat as we took off for Delhi.

At 39,000 ft. Captain Alabaster held an impromptu press conference, probably as near the Summit as anyone would get.

He explained the system of crew training on the *Comet* and the training work being done on the flight. Before joining the *Comet* fleet all pilots are checked out at Bedford with 1. a "death dive" at M = 0.82, approaches to

stall in three configurations, and circuits and bumps; 2. circuits and landings; 3. odd landings, three-engine, two-engine, flapless and overshoots on three and two engines; 4. night flying and 5. check flight involving everything. Average total for the course is 8 to 12 hours.

On this Far Eastern proving flight a typical pilot got the following:

8 take-offs left hand seat,
8 take-offs observed,
8 landings left hand seat,
8 landings observed,
9 let-downs left hand seat,
10 let-downs observed.

By then, we were approaching Delhi, but were delayed by an air display round the airport which added five minutes en-route and 25 minutes holding to the flight—quite costly in fuel.

Forty minutes in the cramped transit lounge and the *Comet* was off again for Calcutta 700 miles away. From Delhi onwards 200Mc/s DME is to be used as a standard aid for the *Comets*.

A brief transit stop at Calcutta—at least that was the schedule. All went well until take-off safety speed was reached on take-off outbound for Bangkok, when the fire warning lights come on in the cockpit. The pilot at the time, Captain Payne, immediately turned back and executed a perfect landing, although well over maximum landing weight.

Captain Alabaster explained that there was no fire, but that moisture had shorted a small time switch which went through its cycle of firing the CO_2 bottles and taking the booster pumps etc. off line, onto batteries.

Realizing that it was the kind of thing that happened in the best run houses—and that that was what proving flights were for anyway—we set out for Calcutta city. Unfortunately the airport machinery was not fully geared for such emergencies with three other aircraft in transit, and we had four hours waiting in the lounge before we could proceed to the exit.

Our enforced stay lasted four days, which showed the problem of spares on a route of such length, even though the offending item was only of such diminutive size. Calcutta provided extraordinary contradictions, with the pavements outside the Grand Hotel crowded with blanketed sleepers, while inside, a branch of the "Bluebell Girls" put on an elaborate cabaret.

After an excellent lunch on the third day in the hallowed precincts of the Bengal Club, we stood in the doorway and watched thousands of workers streaming past, each gripping a hammer and sickle flag. How the British stalwarts of bygone years looking out of their paintings on the Club walls must have turned in their frames!

CO_2 bottles were replaced, together with the necessary non-return valves and the all-important time switch renewed, and everything was ready for continuing the flight to Rangoon. No further fire warning hindered our night take-off, and soon we were cruising smoothly at 36,000 ft.

Twinkling lights below and an announcement that we were over the Schwe Dagon Pagoda heralded the approach into Rangoon, where the temperature was 82° and the ground air conditioning unit created a fine cool mist in the aircraft.

A cup of coffee in Rangoon's small, but very modern airport building, and the *Comet* was ready to press on to Bangkok and then Hong Kong by dawn.

On the one-hour Rangoon-Bangkok leg we dined on food which seemed strangely familiar. Terry Barzilay, our veteran stewardess (she would not reveal just how long she had been with the Corporation), pointed out that the meal was "Joe Lyons" of London. Due to widely differing local standards of hygiene and cooking down the route, much of the food is shipped from the U.K., deep frozen and kept in store at places like Calcutta.

Bangkok proved to be a modern airport, but still with the outdated system of putting transit passengers through passport control and right through the building, instead of having a separate transit lounge.

From Bangkok we cruised at 37,500 ft. to Hong Kong to make a daylight landing, as the approach equipment for the new runway there had not been installed and night landings were prohibited.

"The dawn came up like thunder" to quote Kipling's phrase and after dozing we discovered that Hong Kong was out due to thick mist, which is prevalent at the time of year, and we were to head for Tainan in Formosa.

Airports on the Far East Route are not Ready for the Jet Age

Place	Present main runway (ft.)	ICAO * recommended length (ft.)	Recommended date	Heaviest jet foreseen at that date	Aircraft weight in 1,000's lb.	Remarks
Beirut	7,808	Adequate	1959	707/320 707/420	—	Runway extensions planned. No date. New transit lounge required—work under way.
Cairo	9,350	10,500	1960	707/320 707/420 DC-8	278 237 259	Extending runway to 10,900 ft.; completion end 1959.
Baghdad	7,054	9,000	1960	707/320 DC-8	255 252	New airport under consideration for 11 years. No sign yet. No work started.
Damascus	8,366	10,500	1960	707/320 707/420 DC-8	260 272 251	Planned extensions to 10,500 ft. New terminal planned, but no date.
Bahrain	7,500	—	1959	707/120	—	New terminal building work just commencing.
Istanbul	7,546	7,700	1960	707/320 DC-8	250 248	So far no plans for improvement. Extensions needed, particularly for transit passengers.
Teheran	9,840	13,000	1960	DC-8 707/320	275 271	Runway extensions planned to 12,500 ft. in two stages. Terminal building excellent.
Karachi	7,500	11,500	1959 1960 1961	707/320 707/420 DC-8	265 271 287	Runway extensions now under way to 10,500 ft. Problem of jets parked away from terminal.
Delhi	7,500	11,700	1960	707/420	280.8	New runway planned for end 1960, 10,500 ft. Poor transit facilities. New ILS going in.
Bombay	8,250	10,900	1960	707/320 707/420	260 253.4	Extensions to terminal planned—no date. Runways being extended to 10,500 ft. by 1960.
Calcutta	7,000	8,500	1959 1960	707/320 707/420	260 253.4	One runway now being extended to 7,560 ft. by summer 1959. Second runway 8,500 ft. by mid-1960. VOR by summer 1959.
Rangoon	8,100	9,500	1960	707/320 DC-8	255 258	Extensions needed—no date. Modern terminal building.
Bangkok	9,843	10,500	1960	DC-8 707/320	248 250	New transit facilities planned. At present all transit passengers pass through passport control. Runway extensions not so far planned.
Kuala Lumpur	6,000	6,200 6,700	1959 1961	Comet 4 DC-8	140 214	Difficult airport. Extensions planned 1. to 7,500 ft.; 2. to 9,200 ft. 14-ft. railway embankment at end of runway at present.
Singapore	8,000	9,500	1960	DC-8	278	No plans yet for extension. New terminal required—no date.
Colombo (Katunayake)	6,028	9,750	1959 1960	707/420 707/320	263	Entirely new civil airport required for jets. Present runways and facilities inadequate. Runways to be extended by 1961.
Hong Kong	7,730	—	1960	707		New terminal to be built. Passenger facilities at present poor. No further runway extensions planned.
Tokyo	8,400	—	1960	707 DC-8		Extensions planned for runways. Terminal adequate, but second terminal under consideration.

* These figures were prepared at the ICAO meeting at Rome in January for general guidance on future planning.

Captain R. C. Alabaster, captain of the *Comet 4* (right), and I. G. Hasegawa, BOAC District Sales Manager in Tokyo, under fire from Japanese reporters.

Two Japanese stewardesses and a Chinese colleague.

Tainan, however, closed in, and we were forced to set course for Manila in the Philipines. It was comforting to remember that the *Comet* could fly Bangkok–Hong Kong with 100 percent payload, hold at Hong Kong and then divert to Manila with adequate reserves. In fact at Manila we had still 8,000 kg of fuel after 4 hours, 45 minutes flying.

As the sun rose, everyone stirred from their dozing with the inevitable dry mouth, puffy eyes and sticky clothes, plus a good growth of beard—airline passengers in the morning are not a pretty sight.

At Manila the sun was hot, and we encountered the usual problem of keeping the cabin cool in the lower air. If the heating is left on too long on the let-down a cabin can become unbearably hot, while turning it off at too great a height freezes one's marrow. By the end of the flight the crew could judge it to a nicety.

The good lady at shanty-town "Manila International" was somewhat surprised at the invasion for breakfast but coped good-humouredly. Everyone has been waiting for the completion of the new terminal in the middle of the airfield, which has been delayed apparently for lack of funds.

The mist had now cleared from Hong Kong, and the *Comet* headed out at 37,000 ft., climbing later to 39,000 ft. Soon the charming pattern of islands and the Chinese mainland appeared on the horizon. The approaches of Hong Kong are tortuous with rocky cliffs rising on all sides, but the *Comet* is exceptionally docile and easy to handle under such conditions.

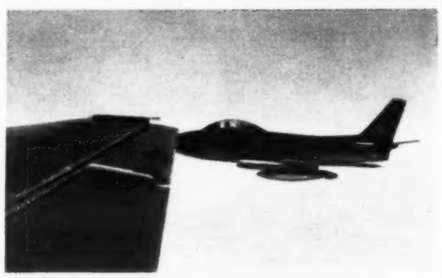
We finally turned over the bay and touched down on the new 7,730 ft. runway, which for most of its length juts out into the sea. Back tracking down the runway, the *Comet* turned and gave an extraordinary display of its take-off capabilities, climbing away at about 30° over the city and the hills. It is the only time on a civil aircraft I have ever had the curious sensation of watching people in the street getting smaller and smaller instead of just passing away aft.

Landed once more, we could see that the authorities had levelled the hill at the end of the runway and closed the two old short runways on the original airfield. The airport buildings are extremely small and cramped, but a new terminal is to be built, as befits one of the most important air junctions in the East. The *Comet* presents no snags for the Corporation on its operations at the airport, but airlines with the big jets may have to trim their weights and payloads, as the runway length will not be extended and no more mountains can be removed.

A whirlwind tour of Hong Kong and Kowloon, inevitable and enforced family shopping, an evening exercice with chopsticks and Chinese food, a brief sleep, and we were once more ready for take-off for Tokyo.

Another spectacular take-off, cruise climb to 35,000 ft. and we were on our way via the Southern tip of Formosa, and Okinawa (of U.S. Marine fame). Cruising along, minding our own business, and cleared on the airway we were suddenly aware that two Nationalist

Hong Kong airport



On the way to Tokyo a Chinese Nationalist pilot flew his *Sabre* within six feet of the *Comet's* starboard wingtip.

Chinese *Sabres* were taking an unusual interest in our progress. While one pilot stayed just aft, the other proceeded to show off in an extremely dangerous fashion by tucking his *Sabre* in 6 ft. from the starboard wingtip and staying there.

The *Comet's* wingtips were not visible from the cockpit and until told by someone in the cabin, the Captain was unaware he had company. A stiff upper air gust or manœuvre by the *Comet* could have ended in a disastrous collision. Fist shaking and other less polite gesticulations only seemed to amuse the *Sabre* jockey who finally peeled away, apparently highly delighted.

The matter was reported, and later the Formosan Defence Minister denied the incident ever occurred. Presumably the 57 people on board saw a mirage, and the yards of film taken of the *Sabre* were just imagination.

Night scene in Tokyo.

No further incidents occurred in the 3½-hour flight, and just before lunch we let down through cloudy, misty weather to do a GCA approach into Tokyo airport.

The *Comet* brought out reporters and photographers in swarms, and we retired to a special room in the modern terminal where the Captain and passengers could be "grilled".

Due to the earlier delays at Calcutta, my stay in Tokyo could only be counted in hours. We chose to go by taxi from the airport to city-centre; after 40 minutes of hair-raising high speed weaving in and out of the traffic, I realized why the Japanese call their cabs "Kamikaze".

Tokyo out-Broadways Broadway for shop fronts and neon lights, even to a full size illuminated motor car about 150 ft. up on a tower just off the Ginza.

My *Britannia* back to England was due to depart at 1 a.m. on Saturday morning, but I was determined to shop, eat a good steak at Suehiro's and see one night club before departing—and I made it. Back at the airport, I checked in, and the baggage clerk summed up the feelings of BOAC personnel down the route when he said, "Ah, you have been on the *Comet*. When services start in April we shall really take the traffic."

And so, back once more along the 7,000-mile route, this time in the luxury of a first class seat on the *Britannia 102*, which for comfort takes a lot of beating. All this plus a succession of BOAC assistant stewardesses, Japanese, Chinese, Pakistani and Indian. On the long flight it was brought home just how much this is a sector traffic route, where frequency and intermediate stops make the profit.

I was the only passenger to fly all the way Tokyo–London. Thirty passengers got off at Hong Kong and about the same number joined; at Calcutta we off-loaded 10 and took on 27; 19 more joined at Delhi, leaving only two empty seats out of the 59; reshuffles came at Karachi, Teheran, Beirut and Rome, until finally, on Sunday afternoon, right on time, the *Britannia* touched down at London Airport in dull weather, and I walked in a slightly sleepless daze across to the decrepit huts which still rejoice in the name of London Airport North.

U.S. Jet Traffic in its Freshman Year

By Douglas Cornell, Interavia Correspondent, New York City

On October 26th, 1958, Pan American World Airways sent aloft from New York International Airport its first regularly-scheduled Boeing 707-121 transatlantic flight (New York–Paris–Rome), thus marking the beginning of the most expensive venture in the history of U.S. commercial aviation. Together, U.S. airlines have invested approximately $2,600,000,000, or four times the valuation of their present equipment, in jet and turboprop aircraft. No less than twenty-five carriers have placed orders for 308 pure jet and 252 turpoprop aircraft.*

Pan American took delivery of its Boeing 707–121s on August 15th (returned and redelivered on November 21st), September 29th, October 16th, October 30th, November 30th, and December 19th, 1958, for a total of six aircraft. Two 707s were placed in service on October 26th, three in November (on the second, third and twenty-first of the month), and one in December. After the inauguration of daily flights to Paris and Rome on October 26th, the airline began daily 707 flights to London on November 16th. Since this date, London flights have been reduced to six per week and the Paris–Rome flight has ended at Paris except for one day per week. On the remaining days a piston aircraft has been shuttling between Paris and Rome.

On March 25th, 1959 Pan American World Airways carried its 50,000th jet passenger – Mrs. David Barbour, of Akron, Ohio – across the Atlantic. Mrs. Barbour was made an honorary member of the crew and is here seen receiving a stewardess pin from Captain Samuel H. Miller.

During the first six weeks of its regularly scheduled jet passenger flights, Pan American carried 12,168 passengers on its transoceanic flights for a load factor average of ninety-four percent. By

* The airlines and their orders are as follows: Aloha Airlines (Hawaii): 3 Fairchild F-27s; American Airlines: 25 Boeing 707s, 25 Boeing 720s, 25 Convair 600s, and 35 Lockheed *Electras;* Bonanza Airlines: 6 Fairchild F-27s; Braniff Airways: 5 Boeing 707s, 9 Lockheed *Electras;* Capital Airlines: 9 Convair 880s, 60 Vickers *Viscounts;* Continental Airlines: 4 Boeing 707s, 15 Vickers *Viscounts;* Delta Airlines: 8 Douglas DC-8s, 10 Convair 880s; Eastern Airlines: 20 Douglas DC-8s, 40 Lockheed *Electras;* Mackey Airlines: 2 Fairchild F-27s; National Airlines: 3 Douglas DC-8s, 23 Lockheed *Electras;* Northeast Airlines: 9 Vickers *Viscounts;* Northern Consolidated Airlines: 3 Fairchild F-27s; Northwest Airlines: 5 Douglas DC-8s, 10 Lockheed *Electras;* Ozark Airlines: 3 Fairchild F-27s; Pan American World Airways: 23 Boeing 707s, 21 Douglas DC-8s; Pan American Grace Airways: 4 Douglas DC-8s; Pacific Airlines: 6 Fairchild F-27s; Pacific Southwest Airlines: 3 Lockheed *Electras;* Piedmont Airlines: 8 Fairchild F-27s; Trans-Caribbean Airways: 1 Douglas DC-8; Trans World Airlines: 33 Boeing 707s, 30 Convair 880s; United Airlines: 11 Boeing 720s, 40 Douglas DC-8s; West Coast Airlines: 6 Fairchild F-27s; Western Airlines: 9 Lockheed *Electras;* Wien Alaska Airlines: 2 Fairchild F-27s.

The Pan American Jet Clipper "Mayflower" (Boeing 707–121) at Idlewild.

Pan American World Airways was the first U.S. airline to inaugurate scheduled jet services, on October 26th, 1958...

...closely followed by American Airlines, who opened non-stop New York–Los Angeles service on January 25th, 1959.

March 25th of this year, the airline had carried its 50,000th jet passenger between the United States and Europe.

"Our average load factor since inception of service has been over ninety percent," a Pan American official told this writer recently. "In the most recent week available the breakdown was thus: Idlewild/London – ninety-two percent; London/Idlewild – ninety-three percent; Idlewild/Paris – ninety-one percent; Paris/Idlewild – ninety-seven percent.

"Parallel propeller services have been holding up well, fluctuating between seventy-eight percent and sixty-five percent, which is very high for this time of year.

"Our operations staff feels that for a completely new aircraft – new in design and operation – our utilization has been excellent. They are not prepared at this time to release figures, but we can give you mileage: in a current period the average per day per plane mileage was 3,520 for the 707; 2,385 for the DC-7; 1,934 for the DC-6. Obviously, with Pan American operating daily service to Paris, six times weekly to London, and with National Airlines using the same aircraft to operate twice daily service between New York and Miami, utilization has been very high."

*

The first select corps of twenty-five Pan American World Airways' captains has just completed an intensive "post-graduate" jet training course at New York International Airport and flight instruction at New York and Miami, Florida. "These men are proven pilots with usually about twenty years of flying experience and more than 10,000 hours flight time," says Harry Canaday, who heads the course's ground classes.

The ten-week course began with fifteen days of classroom instruction, including illustrated lectures, study of aircraft operation and route manuals and familiarization through schematic mock-ups. Subjects included aircraft systems, powerplants and pneumatics, emergency equipment and procedures, aviation medicine and high altitude physiology, radio and electronics, communication, dispatch, aircraft performance, cruise control, weight and balance, and flight planning.

The recently-completed course ran as follows: (1) following fifteen-day classroom sessions, written examinations covering all phases of ground studies were administered to each jet captain; (2) familiarization sessions in jet cockpit on flight controls, engine instruments, and navigational and electronic equipment; (3) Boeing 707 jet simulator work; (4) fifteen hours of flight training including (a) practice engine starts, taxiing, take-offs, medium altitude flights involving normal and steep turns, slow flight stalls, and recovery from unusual attitudes, jet engine shut-off and re-lighting operations during various maneuvers; (b) jet training flights at normal operating altitudes of 30,000 to 35,000 feet, including turns, stalls, other maneuvers, high speed flight, fast let-downs simulating decompression procedures; (c) one-engine shut-off during take-off with training in lifting jet with three remaining engines, circling field, and making three-engine landing; crosswind take-offs and landings, and day and night flight training; (d) two or three regularly scheduled flights with training as co-pilot; (5) "final examination" check flight, before qualification as Jet Clipper captain. Pan American reports its overall jet pilot training is proceeding according to schedule.

Load factors above 90 percent: highly satisfied executives

Juan T. Trippe, President of PAA, with Jet Clipper Captains Samuel H. Miller (right), skipper of the first scheduled New York–Paris trans-Atlantic flight (October 26th, 1958), and Waldo Lynch (left), who succeeded in righting his 707 when it went into a dive on February 3rd, 1959.

C. R. Smith, President of American Airlines (right) takes over the log book and keys for the company's first Boeing 707 Jet Flagship. With him, from right to left, are Captain Hamilton Smith, Captain Charles Macatee and O. M. Mosier, Vice President – Operations.

Warren Lee Pierson, Chairman of the Board of TWA (far left) and E. O. Cocke, Senior Vice President – Sales, with the crew of their first 707 on the occasion of the inauguration of the San Francisco–New York service (March 20th, 1959).

As a result of its five-year-long "paper jet" operations, Pan American has not encountered the need for any major changes in its overall jet flight program. "That precise and technically realistic transatlantic operation prepared us for the actual operation of the aircraft," a company spokesman reported to this writer. "Only minor modifications in such things as take-off techniques have had to be made since then, plus scheduling changes made necessary by various airport restrictions, much of which is very complex and not for our comment because of government-to-government negotiation. Here is what we can say:

"*Idlewild:* We are still operating under take-off restrictions requiring that we be at 1,200 feet over nearby communities. This operation is proceeding normally and without complaint. Since we have had 10,000 feet of usable runway there (after December 26th) our non-stop performance eastbound to London has been over ninety percent (and would have been just under 100 percent if it had not been for inclement terminal weather). The figure for Paris is over seventy percent (and would have reached eighty-five percent or higher if it had not been for Paris area weather).

"*Le Bourget:* We operate there with a take-off restriction which forces a westbound landing at either Santa Maria or (more often) Keflavilk, instead of the normal westbound landing at Gander.

"*London:* We operate with similar community altitude restrictions on take-off at London.

"*Rome:* Since we neither land nor take off at Rome with full gross loads, there is no problem there."

While detailed statistics on other aspects of Pan American's first six-months' experience with jet airliners are not yet available, on the whole, says Pan American Vice President Harold E.Gray, "our difficulties in introducing the Boeing 707 have proved somewhat less than the average for piston planes."

Pan American's future plans include the possibility of a once weekly Jet Clipper operation later this year between New York and Buenos Aires by way of Caracas and Asunción, Paraguay. They also include plans for transpacific operation with either DC-8s or 707-321s, to begin perhaps

TWA Training for the Boeing 707

Checking the electronic equipment in the cockpit of the Boeing 707 during transition training.

Trans World Airlines has traditionally been noted for the excellence of its flying training programs, but in planning for the introduction of the jet transports TWA's Flight Training Department came up with an unusually comprehensive course of instruction designed to achieve maximum safety in flight operation and maximum performance from the aircraft.

Planning for this course started as early as 1956, when experts began an analysis of military experience with jet equipment coupled with TWA's anticipated requirements, and evolved recommendations as to how much time flight crews should spend in each area of training—ground school, simulators and flight transition.

In January 1958, a selected group of instructors and supervisory personnel started a series of courses at the plants of the various manufacturers involved in 707 construction—the airframe builder, the engine manufacturer and companies building components and equipment.

Earlier, TWA had ordered from Link Aviation a *707 simulator*. This masterpiece of electronics is a replica of the 707 cockpit complete with every instrument and control. It can be "flown" exactly as if on a scheduled operation, familiarizing flight crews with the 707 airplane characteristics with less expense. Coupled with the simulator, the *Link Visual System Mark IV*, a T.V. system, projects film onto a cockpit screen of the exact configuration of an airport runway, adding extra realism to simulator training. The simulator and visual adjunct were installed in early 1959.

Flight crew training started in early 1959, the first line crew class consisting of eight captains, eight first officers and eight flight engineers. Each course comprises ground school training, simulator training, transition training in the actual aircraft, and, finally, line indoctrination flights. — Pilots spend four weeks in school, including simulator time, and flight engineers have a five-week course, including training in maintenance.

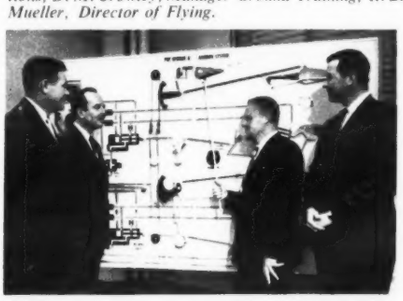
The ground school program for pilots begins with a "familiarization course": 60 hours of class-room instruction in every conceivable area of jet operation, from structures and electrical systems to aerodynamics and navigation, including associated items such as high altitude physiology.—Then the pilots proceed to the 24-hour "*qualification course*" which gives them a review of aircraft systems (8.5 hours), and of aircraft performance and flight planning (6 hours), followed by normal operating and emergency procedures (3 hours) and the meteorological aspects of high speed flight (4.5 hours). The trainees then have to pass an examination.—*Flight engineers* participate in similar familiarization and qualification courses totalling 60 hours.

During the qualification portions of their ground school training, both pilots and flight engineers start *simulator training*. For pilots this includes cockpit familiarization, ground handling, instrument work, take-offs and landings, normal and emergency procedures under realistic conditions (the Link simulator can be made to induce any possible type of flight emergency). TWA captains receive a minimum of ten hours at the simulator controls and two hours on familiarization with the flight engineer's panel, whereas first officers do only six hours at the simulator controls and then are checked out at the flight engineer's panel.—The flight engineer's simulator training (8 to 12 hours) is similar to that of pilots and first officers, with concentration on engine and systems performance.

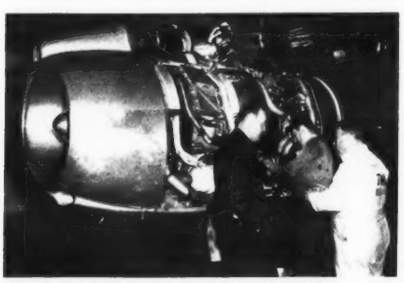
The *transition program* provides a minimum of 14 flight hours per crew: the captain flies 10 hours (including two hours of "type rating" time for Federal Aviation Agency certification), whereas the first officer flies four hours, and the flight engineer a minimum of six, concurrent with the pilots. The basic program includes: 1. equipment instruction (aircraft inspection and cockpit familiarization) 2. ground maneuvering and taxiing; 3. air work, including level flight handling, normal and climbing turns, level flight and turns with one and two engines out, steep turns, slow flight with varying flap settings, near stalls, etc. Then come: 4. training in emergency procedures and take-offs, both under normal and engine failure conditions; 5. landing instruction, covering normal landings with various flap settings, cross winds, night landings, approach and landing with engines out, etc., and 6. instrument work, such as VOR orientation and tracking, instrument penetration and ILS approaches.

The final step in flight crew training is "line qualification" where crews are checked out over TWA routes. In this program, captains get 20 to 30 hours of "line time", including one round trip as first officer and one round-trip line check with a supervisor. First officers fly one round trip of about ten hours duration, and flight engineers make one round trip with a supervisor.

Discussing the spoiler and aileron systems simulator of the Boeing 707 at TWA's Flight Operations Training Centre are (left to right) L. R. Hincks, Regional Director; F. D. Hall, General Manager Flight Operations; D. M. Crowley, Manager Ground Training; R. B. Mueller, Director of Flying.



A routine 200-hour line maintenance check of the engines of TWA's first Boeing 707, used for training purposes. Going over one of the engines are (left to right) O. J. Herter, maintenance training instructor (powerplant); R. Hoffman, and C. Carolla.



Last winter National Airlines operated twice-daily round flights between New York and Miami with Boeing 707s leased from PAA. Plans for the next winter season in Florida call for ten daily jet flights in each direction (some with National's own DC-8s, others with chartered 707s).

To speed up baggage handlung American Airlines Boeing 707s are equipped with six lightweight containers to hold up to 35 bags each. Baggage is pre-sorted according to destination.

late this year, or early in 1960; and plans, on file with the CAB, for one stop (Alaska) jet flights between U.S. East Coast cities and Tokyo.

"To meet the requirements of the jet age," says Willis G. Lipscomb, Pan American Vice President, Traffic and Sales, "nowhere is our route pattern as outmoded or more urgently in need of overhaul than between the U.S. mainland, Alaska and the Orient."

According to Mr. Lipscomb, "Pan American's proposal would accomplish the following: (a) establish one-plane jet air service between the principal cities of the United States, Alaska and the Orient, reducing air travel time by fifty percent; (b) provide single-carrier, through service as contrasted with present connecting change-of-plane service; (c) provide a more efficient operation and, hence, a reduction in rates and fares, (d) establish competition with resulting improved service; (e) enable the U.S. business community to establish closer relations with Alaska, our 49th State, and to maintain and improve its competitive position in world markets; and (f) provide new and expanded horizons for travel and cultural exchanges, furthering the objectives of the Free World."

Regarding other U.S. airlines' experiences with jet airliners, a quick glance at the first available statistics shows equally favorable results. Operating today with a total of seven Boeing 707s and nine Lockheed *Electras* in service, *American Airlines* reports that load factors have averaged consistently over ninety-five percent on all jet flights. The first 707 went into service on January 25th for the inauguration of non-stop New York–Los Angeles flights, just two days after American inaugurated its first regularly-scheduled, non-stop New York–Chicago *Electra* flights. A second 707 was added to the New York–Los Angeles flights on February 15th, New York–Detroit *Electra* flights were begun on February 21st, followed by the beginning of New York–Chicago–San Francisco 707 flights on March 22nd, and the addition of the third 707 on the New York–Los Angeles flights on April 1st.

During the first eighteen days of the initial New York–Los Angeles 707 service, American carried some 3,720 passengers out of a total of 3,741 available seats, for a passenger load factor of 99.5 percent, termed by Charles A. Rheinstrom, Executive Vice President, Sales, as "even beyond the airline's most optimistic expectations". More recently, American Airlines President C. R. Smith termed the continued average load factor on the 707 of over ninety-five percent "little short of phenomenal", in view of day-to-day fluctuations in demand, the problems of no-shows, etcetera. "To place this load factor in perspective," he added, "we might note that American's system load factor was 65.6 percent last year (1958), and this was the highest in the industry." As a result of the introduction of jets into carrier service, Mr. Smith sees benefits not only for the country's defense capability, but also for the national economy and commerce, especially as a significant stimulus to the shipment of freight and other cargo by air.

*

National Airlines, which inaugurated Boeing 707 service between New York and Miami on December 10th, 1958, reports passenger load factors consistently over ninety percent, compared with regular aircraft load factors of approximately fifty-four percent. In addition, Lew Dymond, National's Vice President-Operations, reports the following data gained from experience on the New York–Miami 707 flights to date:

"(1) Turn around time of the jet compared to the DC-7 varies by fifteen minutes. The DC-7 takes one hour; the jet takes one hour and fifteen

The low floor level of the 707's pressurized hold is of great advantage for rapid freight handling, as well as the loading and unloading of passenger baggage.

Under-wing pressure fueling of an American Airlines Boeing 707.

minutes. The same size crew is used in both cases. If larger crews were used on jets, we could reduce to one hour, but National does not plan this.

"(2) Refueling time is the same or faster for jets over DC-7s. There are four tanks to fill on the jet, eight tanks on the DC-7. While more fuel must be pumped into the jet, there are fewer tanks, and faster intake of fuel results in increased speed of fueling operations.

"(3) Baggage handling takes the same time with jets as with DC-7s and baggage arrives at the claim area within ten to twelve minutes after the plane lands. The jet is low to ground, making operations faster for the baggage crew.

"(4) Miami can change jet engines if required, but this operation has been carried out only once in some four hundred flights. No jet engine is kept in Miami. Should this ever be necessary, the engine would be flown from Pan American to Miami with special crew to handle operations. National Airlines' maintenance still could do the job if required. Pan American lease calls for only such changes to be done by Pan Am.

"(5) As to the advantage of the 707s over DC-7s, the Boeing is a more productive airplane from every angle. Faster, greater load capacity means cheaper operation than DC-7s. The break-even load factor is less than the DC-7 because of this. (Cost per seat mile—seven to ten cents.)"

Regarding future plans, says Mr. Dymond, "National is not considering reinstating the order for other DC-8s previously cancelled. The jet deal actually helped National's equipment problem for winter traffic this year. The lease calls for six round trips daily between New York and Miami with 707s next season. The lease will be effective again on November 1st, 1959, and extend to April 24th, 1960. National expects to have DC-8s delivered in December. Their 707s will give National ten round trips daily combined between New York and Miami. National will possibly order more DC-8s if the Southern Transcontinental Route award is made, but could handle operations to the West beginning next winter if the award is granted. The first National prop-jet *Electra* began flying the Miami–New York route in April, and a total of twenty-three are on order from Lockheed."

Charles S. Thomas, President of TWA.

Willis G. Lipscomb, PAA's Vice President – Traffic and Sales.

*

No pushing now... there's room for everybody!

Trans World Airlines introduced the first jet passenger 707 service between San Francisco and New York on March 20th, and while few statistics have yet been compiled for release, company officials report that preliminary results appear to be consistent with the favorable reports of other U.S. carriers mentioned earlier.

"Very soon our entire fleet of Boeing 707 jetliners will be in the skies providing similar service between other principal cities of the United States," TWA President Charles S. Thomas told this writer. "TWA will extend its Boeing 707 jet service in the near future to such cities as Los Angeles, Chicago, Washington, D.C., St. Louis and Philadelphia. Next fall we will inaugurate jet passenger service across the Atlantic to Europe with the longer-range Intercontinental version of the Boeing 707.

"With today's transcontinental jet service in the United States, because of the convenience of connections with morning departures from New York International Airport, passengers from Europe bound for the West Coast can continue their journey by TWA's jet flights. This makes it possible for them to enjoy the evening in Paris and lunch in San Francisco the next noon—a foretaste of what our pattern of living will be like in this new jet age."

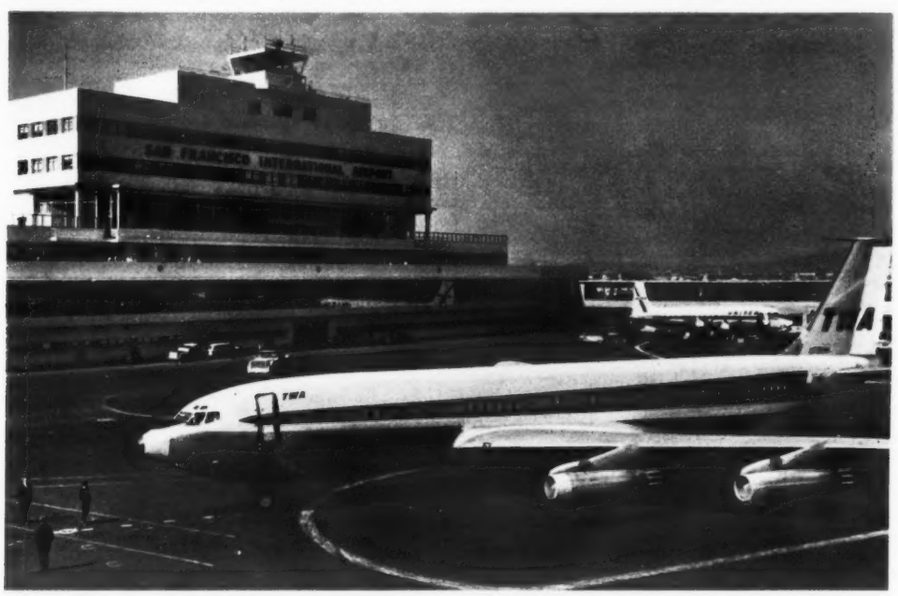
*

With a look to the future, Willis G. Lipscomb, Pan American's Vice President, Traffic and Sales, points out three prerequisites which must be met before commercial jet service can reach the degree of development necessary to remain competitive in world trade and commerce. They include (a) modern jet aircraft, (b) adequate airport and airway facilities, and (c) a suitable route structure. "American technical know-how and the airlines are providing the aircraft," says Mr. Lipscomb. "Communities and the Federal and State governments are hard at work on airports and airways. The ingredient which is lacking is an international air route pattern which will permit proper utilization of these new aircraft and facilities and the providing of fast, convenient, reliable air service.

"The global route patterns of this Nation were mostly established years ago without consideration of the concepts of the jet age. They were based instead on aircraft of limited range unable to operate over remote regions such as the Arctic, small traffic potentials, the resulting need for heavy governmental subsidies, few opportunities for sound airline competition, and the employment of gateway concepts which gave only a few cities the benefits of single carrier service.

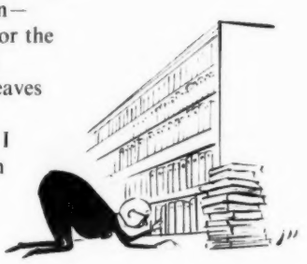
"These patterns must now be changed. Jet transports have no concern as to whether they fly over land, water or ice—the Arctic or the Tropics. They span oceans in a single sweep. They should be permitted to fly straight through from origin to destination rather than via the antiquated, circuitous, broken routes established many years ago. They should be permitted, by means of the time and cost savings inherent in direct, long-range through plane service, to develop the already large international air travel market to a point where frequent, convenient, competitive air service can be provided economically on all major international trade routes and to the principal communities and areas of the United States."

Trans World Airlines opened non-stop services between San Francisco and New York on March 20th, 1959.



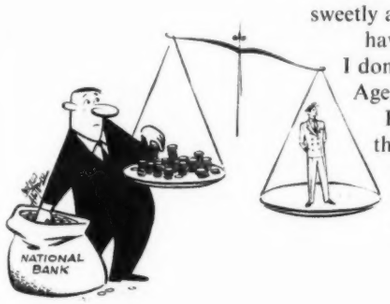
On to the Golden Age!

What, jet aircraft again? indignantly cried Esmeralda, our Favorite Hostess. Can't you ever talk about anything else? As if there weren't dozens of burning questions in the world of aviation—CAB's plans to investigate the ATA records, for instance, or the results of the European Civil Aviation Conference, or even the airlines' problems in South America. But of course, all this leaves you cold.



Now we girls really couldn't care less about the jet age—though I must admit it has one good side. Except for our friends with Pan American and BOAC, we are all in seventh heaven; our old-fashioned planes are flying the Atlantic almost empty, and we have nothing to do but radiate charm and take it easy, while they—poor things—work like galley slaves.

No, what really interests us is the advent of the Golden Age in aviation, when we shall have five days off every week and only have to work two days. And even in those two days all we shall have to do will be to look after robots and electronic brains. We shall have machines to reserve seats, compute flight plans and handle all the book-keeping and orders, not to mention automatic fingers to load and unload passengers. Then we shall all be in clover. When the grand day comes—and Dr. Carnog of Los Angeles promises us it will be soon—that we can fly from New York to Paris in one hour, our cabin duties will be confined to smiling sweetly and looking decorative. In one hour we shouldn't even have time to serve the passengers a cup of coffee!



I don't know whether other industries are so close to the Golden Age, but in the aviation world the signs are most promising. As President Eisenhower said not so long ago, we already have aircraft that are worth more than their weight in gold. A pound of gold costs 500 dollars in the United States, and the latest American bombers, such as the North American and the Convair, cost 17 and 26 million dollars apiece, or 651 and 586 dollars per pound of weight.

Of course, when it comes to salaries for flight personnel, we certainly haven't broken through the gold barrier yet. A jet aircraft captain will get only 30,000 dollars a year, which is no more than 60 pounds of his weight in gold; so he will have to work two and a half years before he has earned his average weight of 150 pounds.

Still, the way things are going, we shall probably get to the point sooner or later when these valuable gentlemen will be weighed against gold each year, like the heads of some religious sects.

I needn't tell you, pursued Esmeralda, who by this time was well in the saddle, that the salaries they pay us hostesses are way below this level. But when we get around to flying only two hours a week and making two trips across the Atlantic in this time, we shall be on the right road. Mind you, even then life won't be altogether a bed of roses. All progress has to be paid for, and we shall have to pay for these advantages in "premature aging". Aircraft get outmoded faster and faster, and the airlines have to renew them more and more frequently. What if the same sort of thing happened to us girls, and we were put out to grass after a few weeks' service? It's not exactly consoling for a girl in the flower of her youth to be discarded as old and outdated. Who knows, we may then look back with longing to the good old days when aircraft never grew old, when the Junkers Ju-52 went on flying for 25 years after it came out of the factory, and the Douglas DC-3 for more than 20 years. The Golden Age seems to be incompatible with eternal youth. Me, despite the commercialism of our age, I'm all for eternal youth. O.K., so I'm not being very original . . . but there's one point on which women haven't changed: they've always been at war with their birth certificates . . .

Jet Travel

The Jet Age is Here

Results, Problems and Difficulties

By Léon Boussard, Montreal

We have now really stepped into the jet age in air transportation. The first results are extremely interesting, but cannot be used as the basis for any final conclusions for the very simple reason that the small number of new aircraft so far in service have been used for only a short time and in high-density regions such as the North Atlantic and the air space above the United States.

American Airlines, who is operating Boeing 707s on the New York–Los Angeles and New York–Chicago–San Francisco routes, reports that at the present time the passenger load factor aboard these jets exceeds 95 percent, whereas the same company's load factor for all its operations on these routes and in the same region last year reached only 65.6 percent—a figure which, incidentally, was the highest for the U.S. airline industry.

Pan American World Airways, whose commercial services with Boeing 707–120s began last October 26th, announces that by March 25th, 1959 it had carried 50,000 passengers on the London–New York and Paris–New York routes, using only three of its six aircraft. It would have taken three piston-engine aircraft more than a year to transport the same number of passengers.

BOAC and *PAA* both record an overall increase in traffic of around 25 to 30 percent in the North Atlantic region since they put jet aircraft into service. Already practically all the economy class seats in the jets are booked for the months of June, July and August.

Although in all good faith it is impossible to draw any general conclusions from these few special cases, which have been limited in both time and space, it is nevertheless abundantly clear that customers, i.e. passengers, have not only accepted but even welcomed enthusiastically the changes entailed in the introduction of jets into the air transport business and have hastened to take advantage of the improvements recently offered.

During this early "running in" period the success achieved has exceeded even the most optimistic hopes. Once again it has been shown that progress cannot be retarded, and that man always finds some way of making full use of new discoveries and new technical and economic advances, even if he does meet some snags along the way. Aviation is still changing the face of our world and the political, economic, social and cultural relationships between nations and men.

This early experience certainly does not mean that all the problems have been solved or that there are no further major difficulties to be overcome.

At first glance the most serious problems at the moment would appear to be those arising on the one hand from the *noise* produced by jet aircraft not only on and immediately around airports, but also over all the surrounding countryside, and on the other hand from the need for *facilitation* of passenger formalities before departure and after arrival.

Every effort is being made to overcome the noise handicap of jet aircraft by means of silencers. Picture shows a silencer for the Pratt & Whitney engines in the Boeing 707.

The solutions applied to these problems today are unlikely to give entire satisfaction when a much larger number of jets comes into service and begins to replace the older reciprocating-engine transports to a serious extent.

The noise produced by the *Caravelle* does not at the moment appear to have serious consequences, and in the Boeing 707, Douglas DC-8 and de Havilland *Comet*, silencers have done a great deal to reduce the bad effects of noise. The problem of noise at airports is thus temporarily and partially solved, particularly if aircraft on the ground are towed to and from the runways, instead of taxiing under their own power. However, the experts who have studied the overall aspects of the noise question and who must take into consideration not only the purely technical difficulties but also the reactions and complaints of the general public have already reached the conclusion that jet aircraft, which would normally cover a long distance at low altitude so as to gather speed before climbing, must begin their climb as soon as possible simply so as not to disturb the communities living in the vicinity of large airports.

Nobody will deny that most of today's air terminals and airports are not rationally organized to facilitate the arrival or departure of increasingly numerous groups of passengers of widely varying nationalities. The biggest progress in this domain has been made in Britain. Passengers arriving at West London Air Terminal can quickly complete all departure formalities at any of the reception desks, whereas in other countries they must still go to the often solitary desk of the airline handling their particular flight. This question of time spent on the ground both on departure and arrival must be solved within the near future. Queues and the herding of people from one point to another must stop. On a recent jet flight the following journey schedule from a hotel in New York to a hotel in London was noted (New York local time throughout):

08.30 a.m.	left hotel
09.05 a.m.	arrived at Idlewild
09.50 a.m.	boarded aircraft
10.19 a.m.	aircraft taxied to runway
10.42 a.m.	aircraft took off
05.22 p.m.	arrived at London Airport

The first Intercontinental model of the Douglas DC-8, with Pratt & Whitney J75 jets, took off from Long Beach, California, at the end of November 1958 for a test flight along the Pacific coast.

The Convair 880 jet airliner made its first flight on January 27th, 1959, the beginning of an extensive flight test programme by the Convair Division of General Dynamics Corporation. The aircraft attained a speed of 540 m. p. h. at 30,000 ft. on its fourth flight.

05.50 p.m. end of passport, customs, and money changing formalities
06.15 p.m. left airport on first available bus
07.00 p.m. registered at West End hotel

Total journey time was 10 hours 30 minutes, and time spent on the ground was 3 hours 50 minutes, or 36.5 percent of the total. Baggage handling also presents very serious problems, as do health formalities, though considerable progress has been made in the matter of customs inspections in most countries, particularly in Europe.

The increase in aircraft productivity, the drastic cuts in flying time on the long international routes, and the general speed-up in communication will have no marked effect on air transport development, economy and policies unless an early international solution is found to problems which are essentially international in character. And the economic problems, whose importance has perhaps been minimized for too long, are undoubtedly the most difficult to solve. It is not sufficient just to fly jets; they must be flown for a definite purpose, with a clear-cut aim such as extending the benefits of air transport to all classes of society. These were the problems set before ICAO's executive group of seven international experts which was set up at Caracas three years ago and is more generally known as the Jet Age Task Force. The group's report has already been studied by the ICAO Council at Montreal and will be submitted to the General Assembly which is due to meet in San Diego, California, next June. The main conclusion of this report amounts to the statement of two obvious truths that are only too often forgotten, namely that it is useless to preach to the converted and that aircraft depend and always will depend on the ground.

In many countries civil aviation agencies are still split up among very different ministries. In some cases they are even subordinate organizations, and their heads have no direct or easy access to the men responsible for overall policies or in control of the purse-strings. Too often the immediate superiors are not too well informed of the contribution which aviation, which knows no geographical or political frontiers, can make to the economy and prestige of their country, through expansion of tourism and trade, of airmail and of meetings and exchanges of all kinds. There can be no efficient organization for air traffic control, meteorology, communications or navigation aid without a strong body of properly trained, responsible and adequately paid experts. At present there are too many experts and other employees who leave the government service for better paid jobs in private undertakings. And it is too often forgotten that a simple official who advises, guides or controls a Boeing 707 Intercontinental from the ground holds in his hands the fate of some 170 persons and a machine worth several million dollars, not counting the serious damage to third parties which may be caused by an accident.

Hence the value of the advice and assistance which can be provided by ICAO, as an organization of 73 governments. Such aid can be offered through the intermediary of the permanent (but mobile) representatives at the regional offices in Paris, Bangkok, Cairo, Lima and Mexico City, by sending technical experts, organizing training grants and courses, dispatching internationally recruited engineers and technicians to under-developed countries, or by financing installations and services to meet truly international needs through international banking concerns. The fantastic and unceasing development of aviation will doubtless lead to the conclusion of new financing and collective aid agreements comparable to those under which weather ships are maintained in the North Atlantic or navigation aids are supported in Greenland and Iceland for the benefit of a group of countries. And in some regions of the world, where many different countries are concentrated within a limited space, there will have to be a pooling of services, equipment and even personnel.

Another solution might be to use operating agencies directly or indirectly subsidized by governments or airlines (or both). These should be independent, non-profit-making organizations operating under the control and authority of governments and responsible under Article 28 of the Chicago Convention for the installation, operation and control of all ground facilities. This solution would provide a more flexible system than can be achieved by direct State control and would go much further towards meeting the needs of airline operators at given times and in given regions. Companies of this nature already exist in Mexico (RAMSA), Peru (CORPAC) and Britain (International Aeradio, which operates in many different parts of the world). Difficulties would, of course, arise when users—i.e., the airlines—were asked to pay charges to cover some of the operating costs, when navigation aids were also used by military aircraft, or when such aids had to be installed in regions, such as the Arctic, where regular commercial flights are few in number.

The overall situation is not entirely discouraging, but there are undoubtedly a number of serious deficiencies in some parts of the world. These deficiencies are well known. They are regularly reported, described and recalled by the ICAO Council, and the work of the Jet Age Task Force has also done much to focus attention on them. Yet the most urgent needs could be met if funds equivalent to the purchase price of one large commercial jet could be spent in the immediate future on the world level, and an annual additional expenditure of four million dollars could be planned for the coming years.

Serious as they are, these difficulties can in no way be described as insurmountable.

The SE. 210 *Caravelle*, which has just gone into service with Air France, would seem to be made to measure for European jet operations. Picture shows this aircraft on a visit to Athens. Third from left, Georges Héreil, President of Sud-Aviation, with Aristoteles Onassis, the shipping magnate and President of Olympic Airways.

Jet Travel

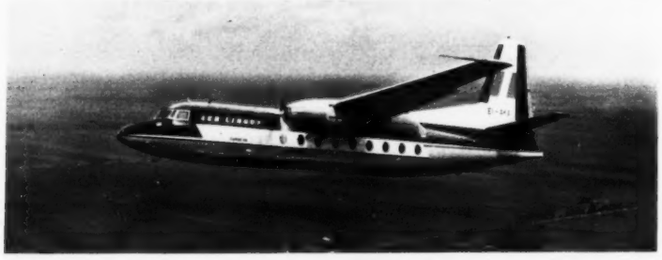
The Allies of the Jet Aircraft...

Turboprop Airliners

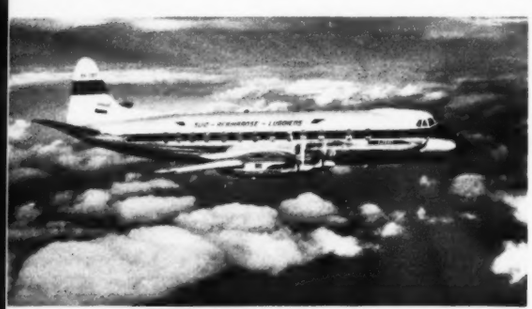
The present issue is devoted to the experience of the first months of jet operations. In actual fact, the "Turbine Age" was inaugurated several years ago when British European Airways took over its first Vickers Viscount 701 in 1953. The following brief survey of turboprop airliners, which can be termed "the allies of the jet aircraft", is therefore included to round out the picture. In addition the reader will find elsewhere in this issue a detailed article on the Vickers Vanguard, and in the February 1959 issue a description of the new Armstrong Whitworth Argosy.

Lockheed Electra for 44 to 85 passengers, powered by four Allison 501-D.13 propeller turbines of 3,750 e.h.p. take-off power each. Span 99 ft.; wing area 1,300 sq.ft.; maximum take-off weight 113,000 lb.; max. payload (capacity limited) 21,195 lb.; max. cruising speed 388 knots; range approx. 2,100 nautical miles with above payload, or 2,380 nautical miles with 17,500 lb. payload. In mid-February 1959 the total order book for the *Electra* stood at 164 aircraft, and the fiftieth *Electra* came off the final assembly line at the end of March.

Canadair 540 for 48 or 54 passengers or equivalent in freight. Ten aircraft have so far been ordered by the Royal Canadian Air Force, under the designation CL-66 or CC-109. Powerplant: two Napier *Eland NEl. 6s* of 3,500 e.h.p. take-off power each. Span 105 ft. 4 in.; wing area 920 sq.ft.; max. take-off weight 53,200 lb.; max. payload 13,668 lb.; cruising speed 282 knots; range 600 nautical miles with max. payload, or 1,515 nautical miles with 6,398 lb. payload. Napier is also offering the *Eland-Convair 340*, similarly powered by *Eland NEl. 6s*.



Fokker F. 27 Friendship for 32 to 44 passengers, fitted with two Rolls-Royce *Dart RDa. 6s* of 1,720 e.h.p. each, or two *Dart RDa. 7s* of 1,990 e.h.p. take-off power each. Span 95 ft. 2 in.; wing area 754 sq.ft.; max. take-off weight 35,700 lb.; max. payload 10,280 lb.; max. cruising speed 243 knots; range 175 nautical miles with 10,280 lb. payload, or 700 nautical miles with 7,100 lb. payload. As is well known, the *Friendship* is also licence-built in the United States by Fairchild, and to date a total of 57 Fokker *Friendships* and 68 Fairchild F-27s have been ordered. Further orders for the *Friendship* by Australia have been mentioned.



Vickers Viscount, built in more than 60 versions to meet the requirements of the various airlines, can carry 56 passengers in the 813 version (picture) operated by South African Airways. Powerplant: four Rolls-Royce *Dart RDa. 7/1* propeller turbines of 1,990 e.h.p. take-off power each. Span 93 ft. 8½ in.; wing area 963 sq.ft.; max. take-off weight 72,500 lb.; max. payload 15,000 lb.; recommended cruising speed 317 knots; range with max. payload 1,040 nautical miles, or 1,430 nautical miles with 10,400 lb. payload. At the end of January 1959 the total order book for all versions of the *Viscount* stood at more than 400 aircraft, and by the same date approximately 370 aircraft had been delivered.

Vickers Vanguard can accommodate up to 139 economy-class passengers in the Mark II version, while the normal first-class layout will seat 97. Powered by four Rolls-Royce *Tyne 1* propeller turbines of 4,795 e.h.p. each, or *Tyne 2s* of 5,525 e.h.p. take-off power each. From 1963 the more powerful *Tyne 3* will be available. Span 118 ft.; wing area 1,529 sq. ft.; max. take-off weight 141,000 lb.; max. payload 17,000 lb.; recommended cruising speed 367 knots; range with max. payload 1,740 nautical miles, or 2,920 nautical miles with 17,000 lb. payload. Orders to date total forty *Vanguards*, 20 for BEA and 20 for Trans-Canada Airlines.

Handley Page Dart-Herald for a maximum of 47 passengers or five tons of freight. Powered by two Rolls-Royce *Dart RDa. 7/2s* of 2,100 e.h.p. take-off power each. Span 94 ft. 9½ in.; wing area 886 sq.ft.; max. take-off weight 37,000 lb.; max. payload (capacity limited) 10,160 lb.; recommended cruising speed approx. 240 knots; range with max. payload 570 nautical miles; with reduced payload of 6,200 lb. range is 1,150 nautical miles.

Armstrong Whitworth AW. 650 Argosy can take up to 75 passengers in its passenger transport version. Fitted with four Rolls-Royce *Dart RDa. 7/2s* of 2,100 e.h.p. take-off power each. Span 115 ft.; wing area 1,458 sq.ft.; max. take-off weight 82,000 lb.; max. payload (capacity limited) 28,000 lb.; recommended cruising speed 256 knots; max. range approx. 2,400 nautical miles with 9,450 lb. payload; with max. payload of 28,000 lb. stages up to 600 nautical miles can be operated. To date Riddle Airlines has placed an order for four civil version AW. 650s.

Bristol Britannia is being built in several versions; Type 300/310 can take up to 133 passengers in the tourist-class layout. Power is supplied either by four Bristol *Proteus 705* turbines of 3,900 e.h.p. each (*Britannia* 100 Series), or Proteus 755s of 4,120 e.h.p. (*Britannia* 300/310 Series), or Proteus 765s of 4,445 e.h.p. take-off power each (*Britannia* 320 Series). Span 142 ft. 3 in.; wing area 2,075 sq.ft.; max. take-off weight of the *Britannia 310* (illustrated) is 175,000 lb.; max. payload (capacity limited) 28,000 lb.; max. cruising speed approx. 345 knots; range 4,100 nautical miles with 28,000 lb. payload. 76 *Britannias* in various versions have been ordered to date.

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IN KEEPING with its high rank and reputation as an international carrier, Swissair was among the first to place orders for pure jet airliners in 1955. Early next year Swissair, which maintains regular service on the North Atlantic, to South America, to Africa and to the Near, Middle and Far East, will provide its North Atlantic passengers with a new dimension in speed, range and relaxation aloft with the newest and most advanced materialization of the commercial jet age—the Douglas DC-8 Jetliners. Providing vibration-free comfort and speed of nearly ten miles a minute these new Swissair DC-8 Jetliners will carry passengers "over the weather" from New York to Switzerland and the principal cities of Europe in little more than six hours, always safe from fire from hydraulic leaks. Swissair's DC-8's will be serviced with Skydrol 500 hydraulic fluid just as Swissair's DC-6 and DC-7 series fleet is protected by Skydrol fire-resistant hydraulic fluids.

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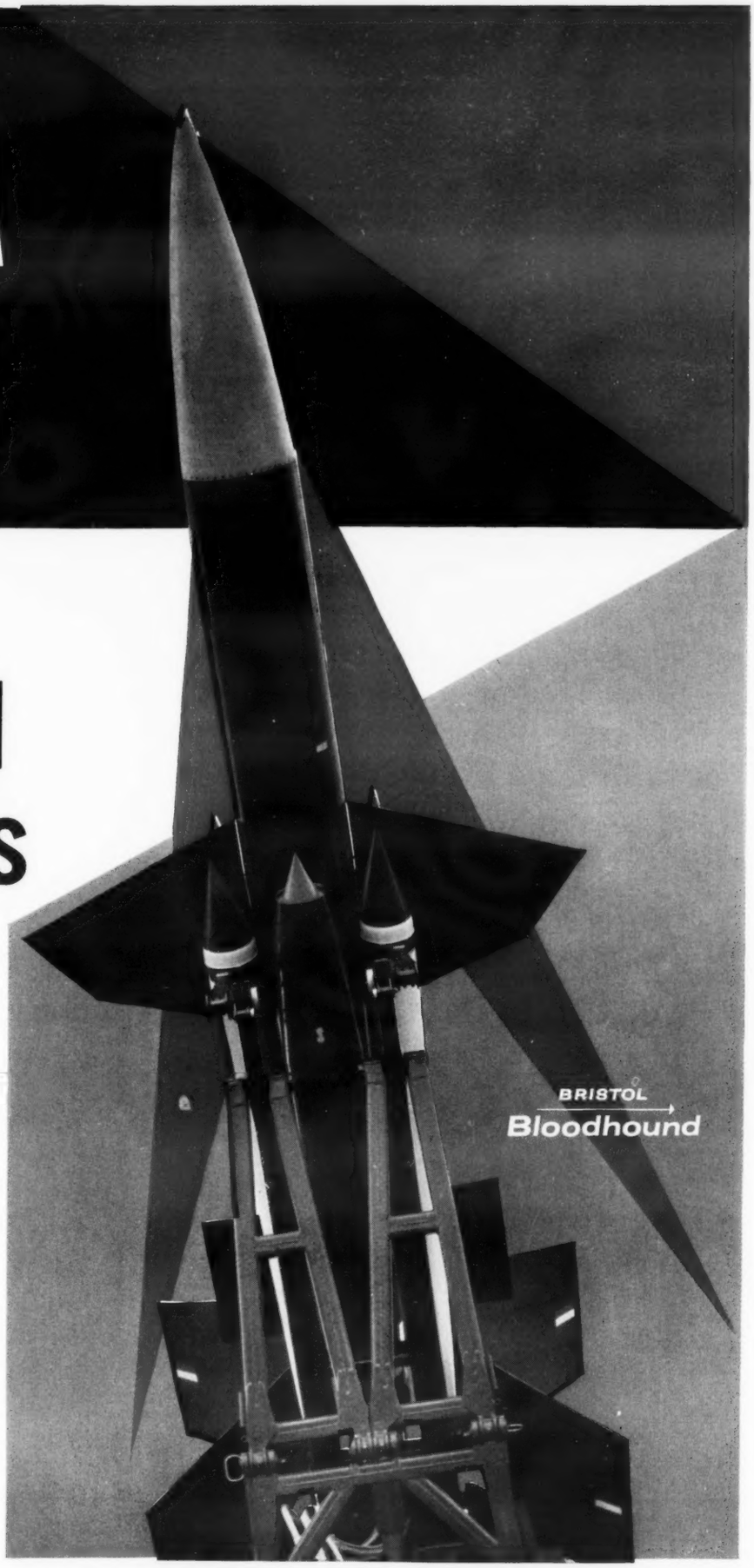

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Convair, Boeing, Douglas... and Seven Questions on Supersonic Transports

Of the some hundred papers read at the 27th Annual Meeting of the Institute of the Aeronautical Sciences (held in New York's Astor Hotel at the end of January 1959), there were three in particular which aroused sustained interest in the air transport industry. Participating members of the airlines—such as the leading engineers from American Airlines, PAA, SAS, Swissair, TWA and UAL—even took a lively part in the discussions. All three papers were devoted to the forward-looking subject of *supersonic civil transports* and bore the following titles:

- *Commercial Air Transportation Beyond the Subsonic Jets*, by R. C. Sebold, Vice President of Engineering, Convair Division of General Dynamics Corporation.
- *Operating the Supersonic Transport*, by M. L. Pennell, Chief Engineer, Transport Division, Boeing Airplane Company.
- *Supersonic Transports—Their Economics and Timing*, by E. F. Burton, Vice President—Engineering, Transport Aircraft Systems, and V. V. Holmes, Advanced Design Engineer, Douglas Aircraft Company.

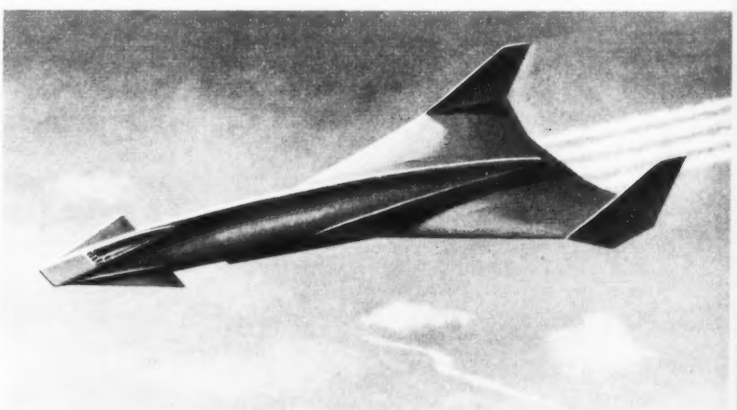
It would be beyond the scope of this article to analyse in full these very thorough and detailed papers[1]. However, an attempt has been made to sort out the points on which opinions converge or diverge, at any rate in broad outline, based on the answers to seven basic questions.

1. Who?

All the leading American manufacturers of civil transports are already seriously working on long-term plans for supersonic commercial transports; this naturally includes Lockheed as well as Convair, Boeing and Douglas[2]. Convair has even gone so far, as *Sebold* pointed out, as to evaluate more than 100,000 supersonic aircraft design parameters in electronic computers and to devote more than 10,000 hours of wind tunnel testing to "the more promising of these various configurations". It is also clear that the international airlines' long-range planners cannot concern themselves too early with the probable future development of their dynamic business ... and that they wish to have their say in this development.

Who will be the passengers in these supersonic jets? Here all the lecturers agreed that the hard-pressed company manager will be among the first. In the words of *Burton* and *Holmes*, "The Mach 3 airplane would allow a harassed businessman (or Secretary of State) to fly from New York to Paris, conduct a normal eight-hour working day in Paris and return to New York within his normal sixteen-hour active day." And *Sebold* produces an even more attractive example from the appointments calendar of a New York businessman in 1970:

8.00 a. m. (Eastern Standard Time)—Wife reminds him it is time to leave for the office. He replies that he has an extra half hour because his meeting is on the West Coast, not in Manhattan.
8.30 a. m. (EST)—Leaves home for airport.
9.30 a. m. (EST)—Takes off aboard supersonic transport.
8.00 a. m. (Pacific Standard Time)—Arrives in Los Angeles.
9.00 a. m. (PST)—Conference begins.



Artist's conception of a Mach 3–5 commercial transport for the seventies, one of several hundred configurations considered by the Convair Division of General Dynamics Corporation.

2. When?

All the speakers agree that the age of the supersonic transport cannot and should not be introduced too soon. After all, the airlines have only just committed several billion dollars to the purchase of subsonic jets, many of which will not be delivered for several years to come, and which must then remain in service for at least a decade to give the airlines time to pay for them. For economic reasons, then, the *early seventies* will probably be the earliest moment for any large-scale scheduled supersonic service. Manufacturers in the United States have therefore decided to go straight on to *Mach 3 to Mach 5* for the next generation of commercial jets, skipping all experimentation with "stopgaps" for Mach 1.5 or Mach 2. Such equipment, says *Sebold*, would be competitive for at best five years, whereas the Mach 3 to 5 transport can be expected to have an operational life of 15 to 20 years.

Although Mach 3 techniques are already so far advanced that no further "technological breakthroughs" are necessary before an airworthy commercial transport can be developed, there are still a vast number of detail questions to be solved concerning aerodynamic and structural configuration, propulsion, flight operation and traffic control. It is estimated, however, that ten to twelve years will be enough for this work.

3. Where?

Only really *long stages*—across the Atlantic, from coast to coast in the United States, to South America, South Africa, Southeast Asia—can be considered for operation by supersonic aircraft. As aircraft produce extremely powerful shock waves (the well-known sonic boom) at Mach numbers from 3 to 5, authorities will have to insist that they fly at subsonic speeds when below altitudes of 35,000 ft. *Sebold* tellingly describes this altitude as the "civilization altitude". Normal cruising altitude for supersonic jets would be between 60,000 and 80,000 ft., depending on powerplant and Mach number. This would mean that the aircraft would consume a relatively large amount of time (and fuel) in climbing at subsonic speed to above the "civilization altitude", before it could accelerate to supersonic speed. Deceleration and descent would have to begin some 300 miles short of the destination. In view of such sacrifices in time and fuel it can readily be understood that supersonic transports could pay only on very long routes. Transcontinental stages of around 2,150 nautical miles would be just about the minimum length, non-stop transatlantic routes, such as Paris–New York, of 3,200 nautical miles would be ideal. At a cruising Mach number of 3, journey time on the former route would be roughly 80 minutes (according to *Sebold*) and on the latter 2 hours 18 minutes (according to *Pennell*).

[1] The full text of the papers and discussions, under the title "Supersonic Transports (Proceedings)", can be obtained from the Institute of the Aeronautical Sciences, Inc., 2 East 64th Street, New York 21, N. Y. ("Sherman M. Fairchild Publication Fund Paper", No. FF-20, price $2.00).

[2] Lockheed did not take part in the New York discussions; however, some idea of the plans under consideration at Burbank can be derived from the "Interview with Hall L. Hibbard" in *Interavia* No. 1, 1958, p. 56.

In addition it must be accepted that future supersonic aircraft must be satisfied with the runway lengths which suffice for subsonic jets, as further increases in runway lengths at the existing major airports must be regarded as out of the question. In view of the enormous thrust of reheat jet engines (which will be indispensable for high-altitude supersonic flight), this would not appear to entail any great technical difficulties; the *noise problem* will, however, have to be solved first. As *D. Gerdan*, Director of Engineering at the Allison Division of General Motors, pointed out in his contribution to the discussion: "...This one problem could well delay the introduction of supersonic transports for many years."

4. What?

When it comes to the probable configuration of future supersonic airlines, however, the views of the different manufacturers understandably begin to diverge.

Convair has investigated the most varied designs (swept wings, delta, double delta), and has come to the general conclusion that the final aircraft "probably will fit into a box 30 to 50 ft. high, 70 to 120 ft. wide and 170 to 230 ft. long" *(Sebold)*. It would have accommodation for about 135 passengers.

Boeing appears to be in favour of a slightly larger type "... about 150 passengers" *(Pennell)*.

Douglas engineers *Burton* and *Holmes* submit the following "General characteristics of a typical Mach 3 transport":

Range (with capacity payload)	3,500 n. m.
Cruising speed	1,725 knots
Block speed at 3,500 n. m. range	1,460 knots
Direct operating costs	$4,000 per hour
Passenger capacity	160
Number of engines	6
Gross take-off weight	500,000 to 600,000 lb.
Manufacturers weight empty	200,000 to 250,000 lb.

Airframe designers will have to make strenuous efforts to keep structural weight down to a minimum (in particular by sandwich construction), despite the use of heat-resistant materials such as stainless steel and titanium alloys, while at the same time getting the highest possible L/D ratio (Convair is confident of being able to obtain an L/D ratio of 7.5 for Mach 3, and of 7 for Mach 5). *Engine designers* will have to provide still further improvements in variable air intakes (maximum ram effect), to increase turbine and afterburner temperatures and achieve still lower fuel consumptions. At the present time only afterburning jet engines are under consideration, although the advocates of ramjet combination powerplants are continuing their efforts.

Extract from the Comments by Dipl.-Ing. Armin O. Baltensweiler, Director of Planning, Swissair, on the Paper by E. F. Burton and V. V. Holmes

"Assuming that these supersonic birds might be with us 10 to 15 years hence, what will they be able to do for the airlines? Due to their extremely high speed, these airplanes will handle a given load potential in a much shorter time which means that a very small fleet of supersonic transports will be in a position to take care of the whole potential traffic of a rather big carrier. A study dealing with the anticipated passenger traffic in 1970 of a typical medium-size airline serving the North Atlantic and the Far East leads to the following conclusions concerning utilization and size of the fleet required:

Fleet requirements to take care of anticipated passenger potential in 1970 on North Atlantic, South Atlantic and Far Eastern routes*

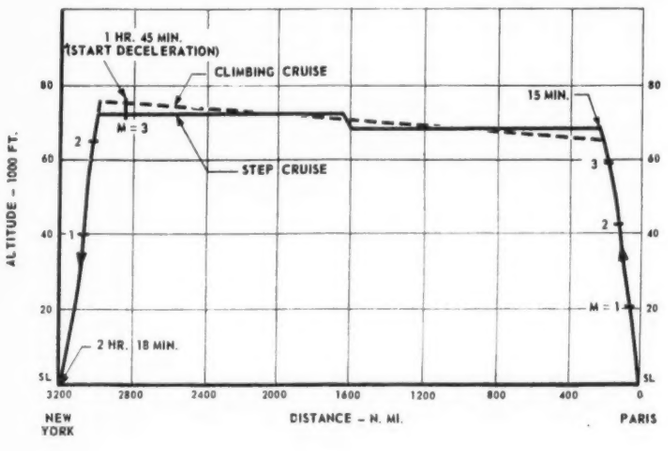
	DC-7C	DC-8	Mach 3 jet
Aircraft hours per year	170,000	48,500	13,000
Utilization per day and aircraft	14 hrs	12 hrs	8 hrs
Number of aircraft required	32	11	5
Spare aircraft required	2	1	1

* Passenger capacity of the DC-8 and Mach 3 jet assumed to be equal.

"The required fleet of Mach 3 aircraft looks rather small indeed, and an airline that was prepared to operate 11 large DC-8 aircraft will be faced with a serious problem before it will be able to downgrade the subsonic jets and to absorb such a small number of supersonic transports instead. The necessity of pooling technical resources between the airlines in order to take care of several small fleets of different types will then become even more obvious. I am very much convinced that the maintenance and overhaul pattern that SAS and Swissair established in order to jointly operate *Caravelles*, Convair 880s and DC-8s will therefore become an extremely popular way of solving some of the industry's knotty problems in the near future and it will become a definite requirement for the supersonic age."

5. How?

Opinions on the details of flight operations are also divergent. One of the questions of immediate interest to the prospective passenger is whether he will be offered windows or not. *Convair* and *Douglas* are of the opinion that windows would introduce an unnecessary complication, especially as any sudden fall in cabin pressure at altitudes of 65,000 to 80,000 ft. must at all costs be avoided. (At normal pressure equivalent to an altitude of 62,000 ft. water boils at body temperature, which would lead to the formation of vapour bubbles in the blood and tissues and hence to immediate death). Instead passengers would be offered individual television screens in front of each seat.



Flight plan for the Paris–New York service, by M. L. Pennell, Boeing Airplane Company: cruising Mach number is M = 3; instead of a continuous climbing cruise (broken line) there will be a step cruise, from an initial 68,000 ft. to a final altitude of 72,000 ft.; flying time 2 hours 18 minutes.

Boeing, however, is apparently not yet fully decided to eliminate the well-known feature of windows (which after all may be only one possible source of explosive decompression). *Pennell* recommends that aircraft be equipped with a water-cooled ram air scoop in the fuselage nose, which would automatically open on a pressure drop and fill the cabin with partially compressed outside air. If, in addition, oxygen is automatically "served"—from masks dropping from the cabin roof as in today's subsonic jets—and if the pilot immediately dives to lower altitudes, there would be little danger to healthy passengers, as the maximum cabin pressure altitude during the dive would not be above 30,000 ft. Of course, the flight would then have to be continued at subsonic speed.

Stewardesses for the supersonic transports—just starting school today—will have to train in mountaineering. *Pennell* has calculated that during the climb, i. e. for a full 15 minutes, the cabin floor will be inclined at an angle of some 12 degrees—and again during descent, in the other direction. Passengers will therefore have to remain in their seats during these flight phases, but stewardesses will have to learn how to serve chewing gum on a slope.

All speakers agreed that *piloting* will have to be still further automated; *Pennell* also advocates automatic air-to-ground position reporting. However, in the event of failures the pilot must of course be able to continue the flight "by hand" and navigate by his own observations and judgment.

6. How many?

Something like 80 supersonic transports would suffice to replace all the 308 big subsonic jets now in operation or on order by the U.S. airlines. Each aircraft would cost three to four times as much to purchase as today's jets, but would have around four times the productivity *(Burton* and *Holmes)*. Actual manufacturing costs may run into $15 to $20 million per aircraft, to which must be added the enormous *development costs*—estimated at a total of around $1,000 million—which could be covered only with substantial aid from the Government, i. e. the taxpayer. However, this will only be the case if military versions are also developed. Whereas the engineering hours expended on the development of the DC-6 numbered "only" 740,000, this figure grew to more than 6,600,000 for the DC-8 and is estimated to reach 10 to 15 million for the Mach 3 transport.

7. Why?

Why did the railway and the motor vehicle displace the stage coach? Why is the long-range aircraft today overshadowing the ship? The answer is simple: the whole history of Western technology represents a single coherent development, in which each revolutionary breakthrough leads to continued evolution. Aircraft, piston engine, turbojet, afterburner, ramjet ... there can be no doubt that the supersonic commercial transport will come. Sooner or later it will be in airline service, and it is therefore in no way too early to begin preliminary studies.

What of the next-but-one generation of airliners, for Mach 5 and above? Leaving aside for the moment the question of propulsion, including the nuclear powerplant, *Sebold* suggests that it may well be a ballistic transport. However, he admits that so far Convair has received "no serious inquiries about a commercial version of the Atlas ICBM ..."

Financial Problems Posed by the Introduction of Jet Aircraft into Regular Airline Service

By Alfredo Crocco, Rome

One unusual and perhaps irrational aspect of the airlines' recent re-equipment policy is undoubtedly the fact that heavy orders were placed before, and not after a detailed analysis had been made of the financial and economic consequences of what has so rightly been called "the jet revolution". Sirens which belatedly sounded the alarm long after the dangers had become apparent were the ICAO Air Transport Committee Report (June 1958), the Cherington Report (June 1958) and the report by the Investment Bankers Association's Aviation Securities Committee issued towards the end of 1958.

The present article, by keeping to known facts, aims at clearly outlining the prospects for the immediate future, bearing in mind that this controversial problem is still being widely discussed.

Diagram 1 shows civil aircraft prices from 1936 to 1960 expressed in dollars per kilogramme of equipped aircraft weight (based on manufacturers' data). *Diagram 2* groups the same data by aircraft "families". These two diagrams show, at first sight, that manufacturing costs for civil aircraft have increased tenfold in twenty-five years for reasons that are well known. The extrapolated curve of *diagram 1* indicates that aircraft manufacturing costs will go on rising, rather than remaining constant, in pace with the latest conceptions of technological progress (supersonic aircraft, nuclear propulsion). This effectively illustrates the progressive financial burden being placed on the airline industry.

The progressive increase of investment capital for the purchase of jet turbine aircraft is justifiable, however, in view of the improved relationship between the capital invested and the productivity of the new transport aircraft. It is apparent from the curve shown in *diagram 3* that the ratio between the purchase price of civil aircraft expressed in dollars and their productivity (payload · cruising speed), after having reached its highest level with the DC-7C and the Lockheed 1649, falls heavily with the aircraft to enter into service by 1960. This feature is easily explained when it is appreciated that the productivity of the transatlantic four-jet transports is about three times greater than that of piston-engined aircraft. With these new aircraft the curve in *diagram 3* falls in a decisive and regular manner. It is evident that this favourable trend will not continue in future years

Diagram 1

Civil aircraft prices from 1936 to 1960 in dollars per kilogramme of equipped weight

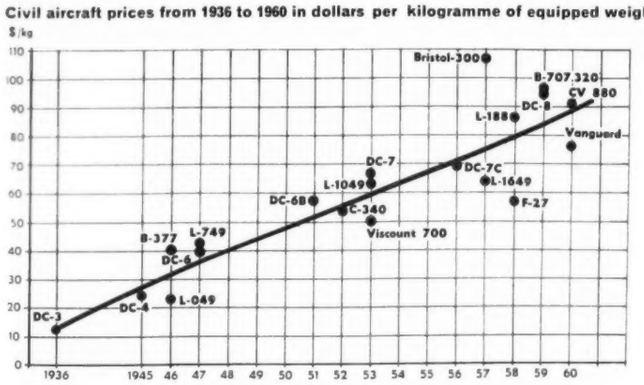


Diagram 2

Civil aircraft prices from 1936 to 1960 ($/kg), grouped according to manufacturers
Douglas, Lockheed, Convair, Boeing, Vickers, Fokker, Bristol

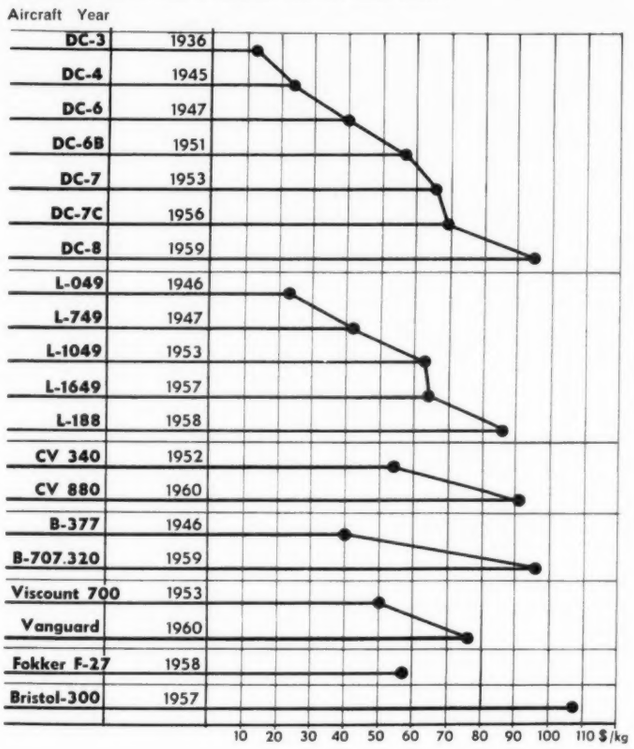
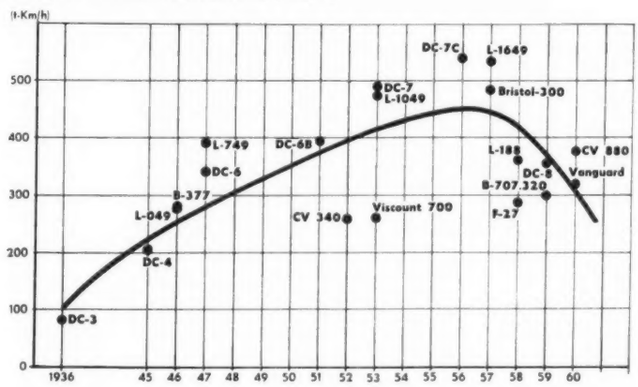


Diagram 3

Ratio of aircraft price to productivity, from 1936 to 1960

The curve shows the evolution of aircraft prices in relation to their productivity (in tonne-kilometres per hour). By this standard the aircraft of 1956/57 (DC-7C, L-1649, Bristol 300) were the most costly, whereas the 1958—60 jets are *relatively* much cheaper. Their actual purchase price, however, is several times that of the latest propeller aircraft.

Aircraft price in relation to productivity (t-km/hr)



unless traffic demand increases sufficiently to ensure adequate utilization of the increased transport capacity. In any case, the financial problem in all its gravity will remain. The increased depreciation load on the airline companies is without doubt one of the most serious problems for the future.

The periodical replacement of an air transport fleet (due to mechanical wear or "aging") ought not to give rise to abnormal financial difficulties if the economy of the airline industry had attained a degree of stability comparable to that of certain other forms of transport. The airline companies should be in a position to finance themselves almost entirely from their own resources thanks to amortization funds, proceeds from the sale of used equipment, and finally, by means of financial reserves[1].

The progressive and considerable rise in manufacturing costs requires for each new investment an outlay which is vastly greater than the liquid funds immediately available. A DC-8, for example, costs three times as much as its predecessor the DC-7C.

It is true that with current financial practice depreciation allowances must be related to existing invested capital instead of to higher future investments. There is also difficulty with the tax collector who is in the habit of taxing as concealed profits, depreciation allowances which are out of proportion to the capital actually invested. Then there is the economic principle which would not allow the airline to exact payment from present users for the improved transport which future passengers will enjoy. This does not alter the fact that the financial plans of the airlines can and must be prepared in good time. These plans must cater for a larger measure of forward thinking and flexibility so that they may be more easily adapted to economic fluctuations. The airlines can then be financed from their own resources and minimize their direct or indirect dependency upon public finance. The problem is much more serious if one considers that the rate of technical progress is positively influencing the cyclic recurrence of financial crises, similar to the one brought about by the advent of jet aircraft.

It can be estimated that about twenty years separates the experimental prototype aircraft based on new technology and their subsequent utilization with civil airlines. Three transformation cycles are already evolving:

- the first, which will reach its climax in 1960 and which began in 1940 with the manufacture of the first experimental turbojets and their military deployment, is that of the transition from conventional aircraft to turbine aircraft capable of subsonic speeds;
- the second, which will probably reach its peak around 1970 and whose experimental prototypes manufactured in 1950 have already given way to operational military aircraft, will enable civil jet aircraft to reach supersonic speeds of from 2,000 to 3,000 km/hr;
- the third, which will see its first test models by 1960 (if they are not already in existence), will culminate in about 1980 with the application of nuclear propulsion to civil transport aircraft.

We shall thus have, if this prediction is exact, a recurring crisis every ten years from 1960 to 1980. This prospect of inevitable progress poses truly distressing economic problems to the airline companies. With the present pace of technical development, hastened along as it is by military requirements, new aircraft categories come into service long before the vast sums invested in existing fleets can be amortized. Each one of these transformations tends to lower the cost of the power employed because of the increased speeds, payloads, range and finally productivity.

The airline companies cannot escape and, indeed, must be ready to surmount the financial crises to which they are subjected by the periodical renewal of their aircraft fleets.

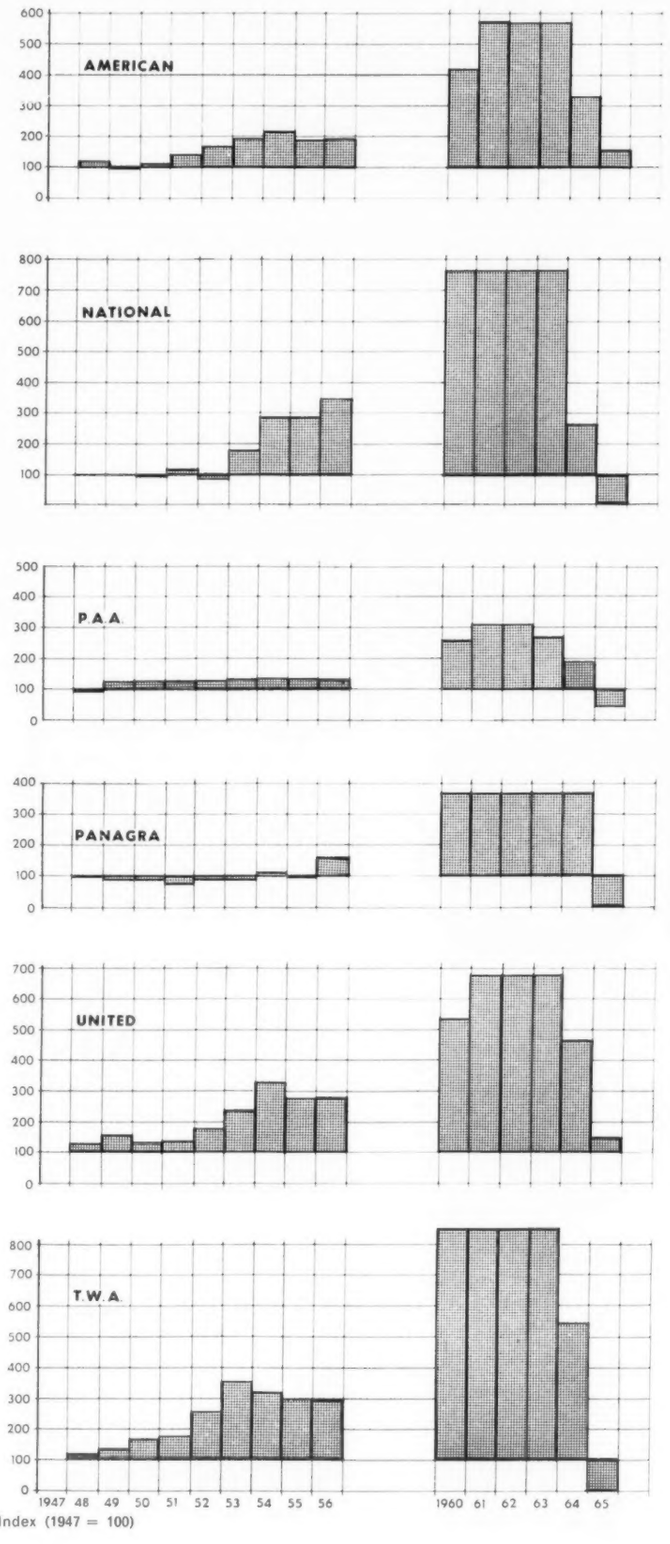
In order to give an idea of the size of future capital depreciations the author has analysed annual depreciation allowances of six U.S. airlines and the major European airlines, as published by ICAO from 1947 to 1956. He has calculated the presumed annual depreciation burden of the new jets and turboprops from 1960 to 1965, taking into account the delivery dates of each particular aircraft and assuming a five-year depreciation period with

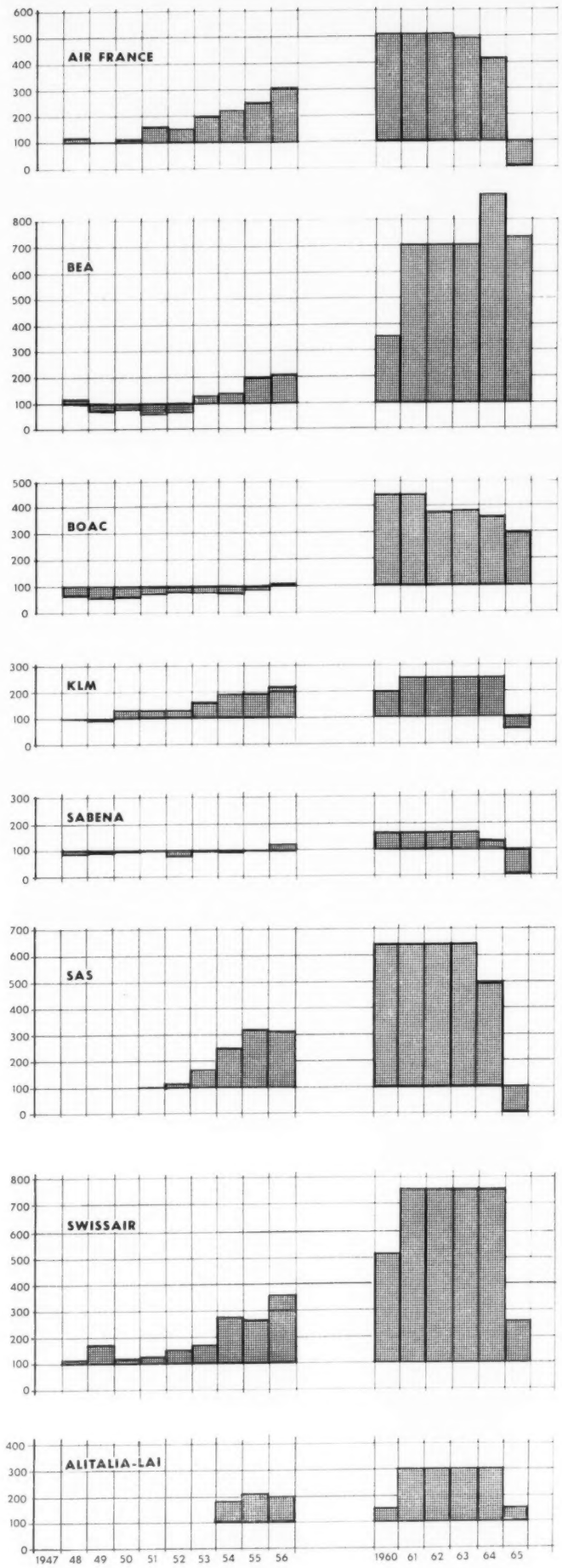
[1] The U.S. airlines have been able to finance from their own resources about 55 % of the purchase price of new aircraft (35 % with depreciation funds, 7.5 % from the sale of used aircraft, 12.5 % with reserve capital). The level of "self-financing" of the European airlines is undoubtedly much lower.

Fleet depreciation in the United States and in Europe

Diagram 4

Variation in annual depreciation allowance for six U.S. and eight European airlines from 1947 to 1956, together with estimates for the years 1960 to 1965. — Based on an index of 100 for 1947.





a residual value of 20 percent. The sums thus calculated concern only the aircraft already on order and do not include the sums relative to any piston-engined aircraft which may still be in service during these six years. The analysis shows for U.S. companies, between 1947 and 1956, that depreciation allowances increased on the average between once and twice, and for European airlines from between once and one-and-a-half times *(diagram 5)*. *Diagram 4* shows, based on an index of 100 for 1947, the variations in the sums set aside for annual depreciation for each company from 1947 to 1956.

It is possible to estimate from an examination of these diagrams that the annual depreciation figures will rise after 1960 to much higher levels than in the past, if the companies adopt a forward thinking policy. The majority of the companies will have to make very considerable increases. The average increase of the total annual depreciation costs for the six U.S. airlines will reach as high as 550 percent, compared with 1947, whereas from 1947 to 1956 the highest point was in the region of 230 percent. The peak for European companies will reach 370 percent as against a maximum of 170 percent from 1947 to 1956.

It is nevertheless true that these increases will be seen in a different light if the annual fluctuations are considered in relation to the variation in total weight of the aircraft fleets, or the fluctuations in total flying hours. The following are average values of the depreciation costs in dollars per ton and in dollars per flying hour from 1947 to 1956 for the six North American companies as well as for seven of the eight European companies (Alitalia excepted, owing to incomplete data).

Depreciation of aircraft fleets in dollars per ton of maximum weight

Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
USA	2,640	2,550	3,570	2,810	3,140	3,080	3,110	3,370	2,870	2,850
Europe	2,260	1,910	1,940	1,810	2,260	2,020	2,250	2,640	3,120	2,960

Depreciation in dollars per flying hour

Year	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
USA	25.91	28.58	34.63	38.18	37.00	40.30	45.39	49.49	39.82	38.95
Europe	49.77	40.59	40.47	38.51	39.32	36.89	42.51	46.04	49.76	51.90

The figures shown in these two tables confirm a fact which is almost a truism: the progressive increase of investment by the airline industry, accompanied by the substantial development of air traffic during the same period, has had only negligible repercussions on total operating expenses, thanks mainly to a parallel increase in annual utilization.

This simple observation logically leads on to the following conclusion: the increase of investments in airline transports is justified only where it gives rise to increased productivity, thus reducing unit load transport costs. This reduction must be adequate to ensure an increase in profit-earning capacity in order to encourage financial investments at reasonable interest rates.

The productivity of an aircraft in service on a given route is the product of its hourly load carrying output (revenue payload times the average speed) and the annual utilization.

The productivity of a route, or air network, represents the relationship between the total productivity of the air fleet utilized and its theoretical maximum productivity, which is given by the product of the available payload capacity multiplied by the cruising speed and the theoretical maximum utilization which is 8,640 hours per year (360 days).

The principal factors contributing to an increase in productivity therefore are revenue payload, average speed and annual utilization.

Now with their new transatlantic jets, the manufacturers have obtained a marked improvement in one of three factors mentioned: namely, the speed; but this has merely complicated the problem of increasing the second factor, namely annual utilization, which in turn depends on improvements in organization and operating techniques.

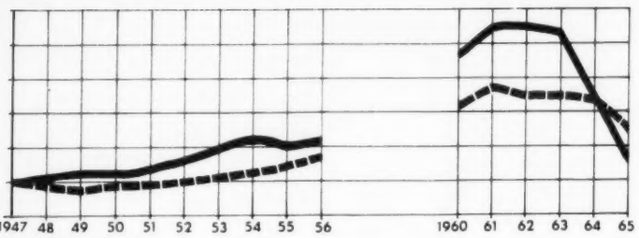


Diagram 5

Variation in average annual depreciation funds for aircraft fleets for U.S. and European airlines in 1947 to 1956, together with estimates for 1960 to 1965. Average values are based on figures for six U.S. airlines and eight European airlines.

Unbroken line: average depreciation allowances for the U.S. airlines.

Broken line: average depreciation allowances for the European airlines.

In order to give the big jets the same range as the last generation of piston-engined transports and to enable them to fly economically, for example, between Europe and the United States, the manufacturers have had to increase the payload capacity. This again makes it more difficult to improve the third factor, that is to say the revenue payload, which in its turn depends upon economic conditions and traffic demand.

If it had been possible to stick to aircraft dimensions like the DC-7C and Lockheed 1649, the transition from piston engines to jets would not have caused all the difficulties and troubles to which the airlines have been subjected. In short it would have been a silent revolution. On the contrary it has created two major worries: namely financial (i. e. investments) and economic (i. e. operational). The first because the air transport industry as a body was not ripe for such financial outlays; the second because only the future can show if full advantage can be taken of the increased capacity offered by jet aircraft and turbine-powered aircraft in general.

The secret for overcoming the difficult period ahead lies in the above definition of productivity: that is, in the maximum possible increase of the three factors: revenue payload, average speed, and annual utilization.

The increase in revenue payload, assisted by the increase in speed, depends principally on a reduction in rates and fares, and the ability of operators to stimulate and liberalize traffic (bigger penetration into potential markets, improved comfort and convenience, and maximum flight safety).

The increase in block speed (the main advantage of jet aircraft) depends upon the convenience of timetables, reduction of lost time, improved and more efficient ground organization and services, improved air traffic control conditions and procedures.

The increase in annual utilization (essential for economy and output) depends upon appropriate changes to itineraries and routes, reduction of servicing time, cooperation between airlines and liberalizing of traffic rights. At the present time 3,000 hours annual utilization for big piston-engined transports is considered high. However, it will be not only necessary, but quite possible to reach a substantially higher level.

It has been calculated, on the basis of strict operating principles, what the annual utilization of an aircraft should be in the case of a "circular" service in both directions, if it were legally possible to create a jet link with DC-8s or Boeing 707s on the route Rome–Montreal–New York–Caracas–Lisbon–Rome. With three aircraft (the third, in reserve, could be utilized on other routes) there could be an annual utilization of 4,108 hours, at an average speed of 790 km/hr. The productivity of the service, with a 50 percent load factor, would be 0.206.

In 1954 (complete statistical data and economic information are not available for more recent years) the average productivity of the six American airlines analysed was 0.153, with an average load factor of 59.7 percent. That of the eight European airlines was, in contrast, 0.087 with an average load factor of 59.3 percent[2].

Increased utilization permits a reduction in the amortization period, assuming equal hourly costs, and increased productivity is the prerequisite to increasing the profit earning capacity.

The increasing growth of investments due to the transition from one re-equipment cycle to another and hence the growing need for more capital on the one hand, and increasing depreciation charges and their effect upon operating expenses on the other, are the major problems associated with the recurring crises of the next twenty years. The airline companies must solve these problems smoothly, without incurring excessive burdens and without imposing excessive sacrifices on the community.

The conditions necessary for their solution are as follows: reduction of amortization periods for the new air fleets which, in general, ought not to exceed five years, and an increase in profit earning capacity, particularly by increasing productivity. The fulfilment of these two conditions presupposes, however, a profound change in thinking, above all by governments and the European airlines.

It is necessary for the future that the airline companies – like all the major industries of our time – should penetrate the rich, fruitful, and dynamic areas of private enterprise. State ownership and control are beginning to reveal themselves as inadequate to meet the requirements of the air transport industry. Its machinery is complicated and slow, its limits and laws are too restricted, dominated as they are by political controls and influences.

In the next twenty years public ownership, direct or indirect, of European airlines, which in the past has been considered profitable and socially equitable, may well become an outworn formula.

The moment has arrived where governments must re-examine and reframe their policies towards a progressive "liberalization" of air transport – a step which hitherto they have been afraid to take. The time is ripe because air transport has prospects of developing towards genuinely economic forms, structures, dimensions and responsibilities instead of remaining within the protectionism of the State with its resulting conservative tendencies.

In the course of the future development of air transport the State must concern itself with other grave and complex problems which it alone can solve, such as ground organization, flight aids to airline operation, checks on the management and international relations of the airlines, safeguards against monopolistic tendencies as well as defending interests of users and the community.

Present financing methods will be of little value in the face of the vast problems of the near future unless the European air transport industry is firmly integrated with national economies and the capital market. Today this industry is still living in artificial prosperity which conceals its underlying weaknesses.

The difficulties of the present crisis, not all of which have been solved, will provide valuable lessons for dealing with the inevitable crises of the future: namely to reconstruct the bridges between air transport and national resources. Capital flows always and spontaneously to those places where it finds freedom of initiative (even if this entails risk), independent and responsible management, a sound investment proposition, and sources of reasonable profits.

Pessimism and optimism are only states of mind. Air transport is, and will be, what the leaders of this industry make it.

[2] *A. Crocco*, "I trasporti aerei nel quadro dello sviluppo dell'economia nazionale" – in *Atti VI Congresso Italiano dei Trasporti 1956*, page 25.

Automation in Aviation Ground Services

By Dr.-Ing. Werner Treibel, Manager of Arbeitsgemeinschaft Deutscher Verkehrsflughäfen e.V., Stuttgart

At first glance it might seem that the aviation ground services offer little scope for automation. Work processes in air transportation would appear to be far too varied in nature, volume and frequency, and the need to adapt working methods to constantly changing operational requirements obviously restricts the field for the far-reaching programming normally essential to automation. However, a closer inspection reveals that mechanization in commercial aviation has greatly increased during the past ten years, that the pressure towards the rationalization of individual work processes is growing steadily stronger and that partial automation has already taken place. Here the driving force is the urgent need to save time—a need which plays a much more important part than the increase in traffic volume or the concentration of similar work processes during peak hours.

With the introduction of high performance aircraft, which reach speeds in the neighbourhood of the sound barrier, cover stages of 3,500 miles non-stop and carry 150 to 200 passengers, time wasted on the ground becomes increasingly costly. Unquestionably, any further shortening of flying times in short and medium haul traffic without a corresponding reduction in handling time on the ground would be uneconomic and would lead to air transport's losing ground in competition with surface means of transport. In other words, in all future automation measures first priority must be given to the need to cut time spent on the ground.

The situation is best illustrated by a few figures. *Diagram 1* shows that the present normal share of ground time in total journey time for a stage of 250 miles and a block speed of 500 m.p.h. is 75 percent, whereas for a block speed of 250 m.p.h. it is only 60 percent. For a stage length of 500 miles the corresponding figures would be 60 percent and 45 percent. Not until long-haul flights are reached does the share of ground time fall significantly: for block speeds of 250 m.p.h. to below 20 percent and for block speeds of 500 m.p.h. to less than 30 percent. If the currently normal block speed of 250 m.p.h. on continental short and medium hauls were increased to 375 m.p.h., this would cut flying time by 20 minutes on a stage length of 250 miles. With a block speed of 435 m.p.h. a total of 26 minutes would be saved. This indicates what cuts in ground time would be necessary to restore the earlier ratio of ground time to flying time.

Diagram 2 shows that even relatively small reductions in ground time can have a considerable effect on total journey time, as a practical example will reveal more clearly: if the Convair 440 *Metropolitan* with a block speed of 250 m.p.h. were replaced on a typical European stage of 250 miles by a Vickers *Viscount 814* with a block speed of 310 m.p.h. the saving in travelling time would be only 8 percent. But if in addition 7½ minutes could be saved in travelling to the airport plus 7½ minutes in formalities at the airport, with a similar saving of 15 minutes at the other end – a total of 30 minutes ground time for the whole journey – this would be equivalent to raising aircraft speed to Mach 1.5. It will also be clear that if the *Metropolitan* were replaced by a *Viscount* on a stage length of 500 miles and again a saving of 30 minutes were made in ground time, then the total journey time would be shortened by an extent otherwise obtainable only by use of a jet aircraft *(Caravelle*, Boeing 720 or *Comet 4B)* with a block speed of 435 m.p.h.

Comparisons such as these throw a very clear light on the effects of ground time on total journey time. The general conclusion can be drawn that, for an economic organization of short and medium stage traffic, an efficient degree of automation designed to speed up handling procedures at the airport is at least as important as an increase in block speeds.

A. Automation at the airport

Aircraft handling

The airport is the beginning and end of every air journey; it is here that goods are transhipped from surface means of transport to the aircraft. At the airport the air traffic control service, meteorological

Diagram 1: Percentage of ground times in relation to total journey time (ordinates) plotted against stage length (abscissa, in km) and block speed (parameter, in km/h). Ground times allowed for (total of city-centre-to-airport time plus handling time) were 1.5 hours for stage lengths up to 800 km (500 miles), 1.6 hours for 800 to 3,200 km, and 2 hours for longer stages. Feeder time allowed is 30 minutes for each airport, that is one hour per flight.

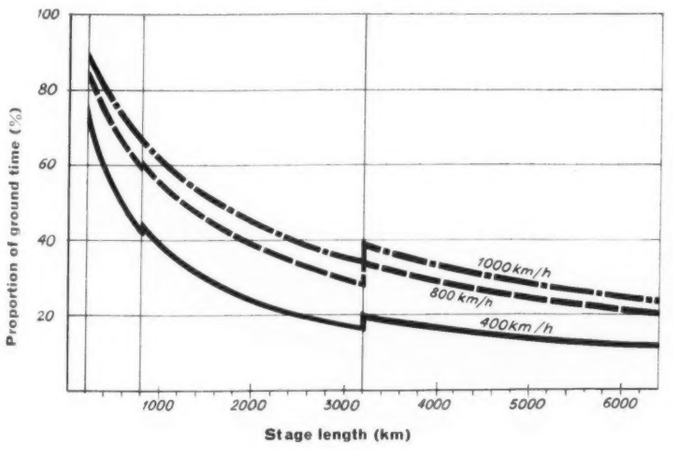
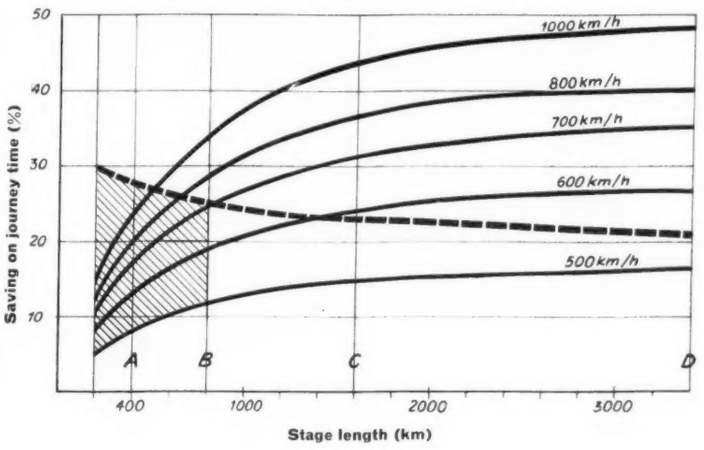


Diagram 2: Percentage journey time saved by increasing block speed above the reference value of 400 km/h (250 m.p.h.). The unbroken curves show the saving in pure flying time obtained for the given speeds (parameters, in km/h) and stage lengths (abscissa, in km). The broken curve indicates the time saved by a 30-minute cut in ground time together with an increase in block speed from 400 to 500 km/h. Ordinate A (400 km) represents the average European stage length (according to Air Research Bureau figures), ordinate B (800 km) the ICAO average, ordinate C (1,600 km) a typical transcontinental non-stop distance, and ordinate D (3,400 km) a typical intercontinental distance.



service, the ground staff belonging to the airport operator and the airlines all work hand in hand to conduct operations rapidly, efficiently and safely. A great deal of the work which the passenger sees is carried out on the apron.

All individual work operations must be so organized that as many activities as possible can be carried out simultaneously without hampering each other. Another essential requirement is that safety measures should not create additional handicaps. In future aircraft purchasers will have to specify maximum permissible times for the various ground handling operations, in the same way as they specify range, payload and speed. It is only in this way that commensurate consideration can be given to requirements both on the ground and in the air and hence an efficient overall pattern built up.

It must, however, be admitted that in the matter of transferring payload from the ground into the aircraft or vice versa there will always be a number of processes which *cannot* be automated. True, the whole operation can be facilitated to a certain extent by what might be called "pre-handling", i.e., by holding goods and passengers in readiness, and by means of special handling equipment, but fully automatic control and performance of handling operations will never be possible.

If aircraft in future are served to an increasing extent by stationary installations – e.g. finger docks with loading bridges – operations will have to be standardized. This will also influence the development of aircraft.

Not until aircraft are adequately adapted to meet ground requirements can any transition from mechanized to automatic aids be envisaged in aircraft handling. Here the handling techniques will have to be adapted to the nature of aircraft movements on the apron.

Passenger handling on the apron

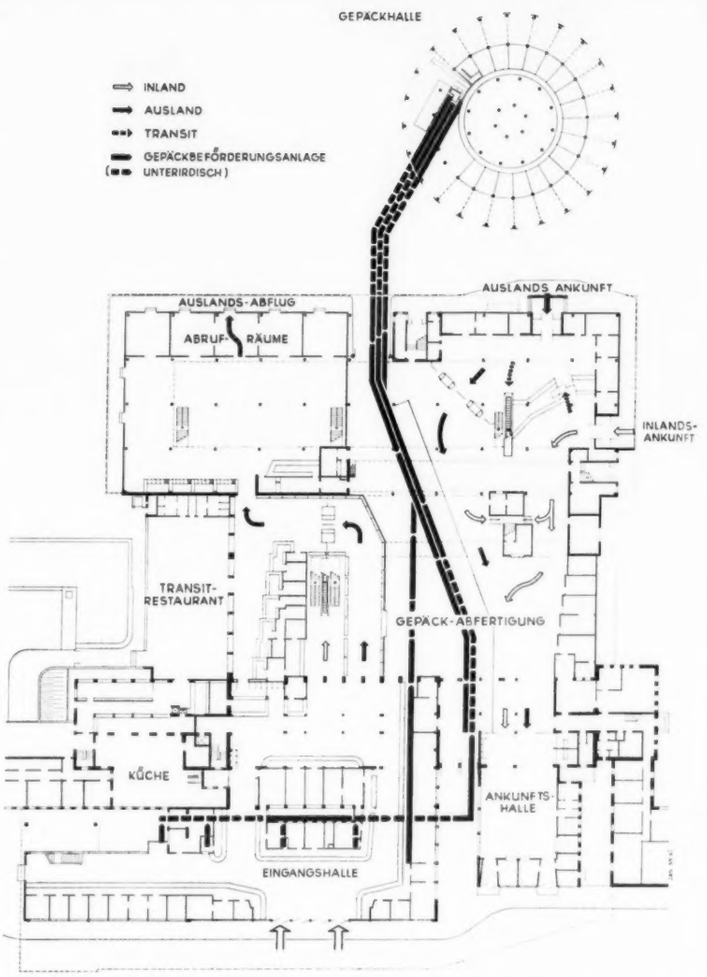
Any effort to automate the loading of persons and goods from the aircraft into the terminal building or vice versa is complicated by the very varied conditions existing, such as the variety of different aircraft types, their employment on short, medium and long stages, on domestic or international services and so on. In many cases the data needed for programming individual work processes are lacking, though on the other hand there is scope for rationalization. This begins with the design of the terminal building and the organization of the traffic flow within the building, and embraces the aprons, with perhaps the installation of fingers, feeder tunnels and satellite apron stations. Whereas some five years ago the latest idea was to standardize the handling of passengers by providing a large number of parallel channels (a typical example is London Airport), more recent thinking in the United States has turned towards the principle of taking passenger flows along horizontal conveyor belts. In other words the experience gained in the handling of baggage and cargo is being applied to the handling of passengers. This step could be followed by partially automatic control of the belts leading to the various aircraft loading positions.

One of the decisive advantages of this system, which has been in operation at Dallas, Texas, airport for the past year, is the automatically controlled motion process.

All in all it can be said that:

When the "goods" to be moved are human beings, special laws come into play! Here some form of "indirect automation", or control via the human senses, can be more successful than a complicated technical automation system.

The ultimate aim in the handling area of an airport should be the automatic cooperation of the passenger (self service system); however, this would necessitate that in future passenger documents are simplified (air tickets), customs and passport checks reduced, baggage handled more intelligently (an arrangement, for example, that hand baggage can be taken inside the aircraft on short and medium stages) and hence that the number and volume of handling processes are reduced.



Ground floor plan of the Frankfurt/Main terminal building showing the baggage conveyor system now being installed.

Baggage handling and sorting

At most commercial airports baggage is moved from the airline counter to the aircraft and vice versa by means of electric trolleys or towing vehicles with baggage carts. Differences in level are overcome by means of chutes, ramps or fork lifts. This produces a broken route, with the inevitable transfer problems. The ultimate aim must therefore be a uniform, automatically controlled baggage handling system. As no efficient designs have yet been found for versatile loading bridges, however, baggage must still be moved between the terminal building and the aircraft by mobile equipment.

The introduction of jet aircraft on short and medium length routes calls for a new attitude to the problem of cargo handling. In some cases extra weight could be accepted in order to save time. For example, to reduce loading and unloading times it might well be advisable to use transport containers. The extra weight involved might be well worth while, if the time spent at transit airports were thereby decisively cut down. Again, the loading of goods from one aircraft into another could be substantially speeded up by organizing baggage sorting points on the apron in front of the terminal building.

At Frankfurt/Main Airport an extensive baggage handling system with electronic control is at present being installed (see drawing). This installation will do away with the need for baggage carts inside the terminal building and make it possible to intercept all transit baggage outside the building. The system incorporates a number of new features and will work as follows:

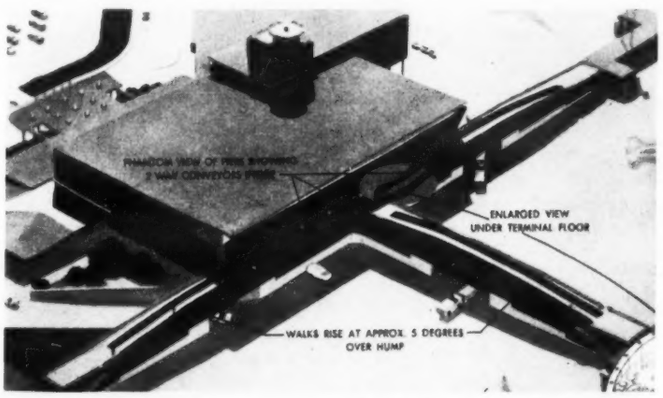
Passengers' baggage passes from the various airline desks down chutes onto the lower floor, where it is collected in groups of a given

number. This is necessary since baggage cannot be loaded onto the conveyor belt until a given length of the belt is free. The first problem to be solved was how the various collection centres should load the belt. For this purpose an electronic interrogation device was installed; this ascertains when the amount of baggage corresponding to the contents of the collection area can be conveyed on the belt without difficulty. As soon as an appropriate length of belt becomes free, the baggage slides onto the belt piece by piece.

As Frankfurt Airport has a large number of airline desks which are not all arranged in line, it was found necessary to interconnect several conveyor belts. An appropriate automatic control ensures that baggage from different airlines is not intermingled.

A third task was to find a method of moving baggage handed in at the city terminal direct from the buses to the apron, without touching the airline counters. To this end an additional belt loading station was provided.

The baggage is moved on the conveyor belt right through the terminal building, on either ground or below-ground level, and finally arrives at a baggage shed on the apron. Here it is distributed to a maximum of 17 different bays, which are set aside for various routes and destinations, to meet the requirements of flight schedules. The baggage arriving by conveyor belt has as a rule been pre-sorted at the airline desk according to route and to a certain extent destination, so that the employee at the control desk in the baggage shed has a relatively simple task. Travel speed is fixed in such a way that all items of baggage can be correctly directed.



Conveyor belt system for passengers at Dallas, Texas, airport. Two-way belts are used.

Baggage is moved into the appropriate bay by means of electronically controlled guides. The bays are equipped with chutes to ensure smooth removal of baggage items from the distributor belt. Transport from the bays to the aircraft is provided by large carts, equipped with conveyor belts to overcome difference in levels.

Baggage from incoming aircraft is transported to the baggage shed, sorted into domestic and international baggage and carried on special conveyor belts into the terminal building. All baggage items carry standard identification numbers in use by all IATA airlines and are automatically directed to the appropriate bays. Each passenger can then collect his own bags from the bays, unless customs formalities intervene.

Maximum handling capacity for the system is to be 1,800 items of baggage per hour, outgoing or incoming. The installation, which is scheduled to come into operation in the summer of 1959, is a decisive step forward on the road to automation of baggage handling.

B. Automatic seat reservation

Although electronic computers for seat reservations have been in use since 1952, their general adoption cannot be expected until the widespread introduction of jet aircraft. As flying times shrink, the need for a rapid and efficient seat reservation and even more so for an information system will increase. The latest installations already go a long way towards meeting this need. For instance, it is possible to connect outside offices (agencies and travel bureaux) direct with the magnetic storage drum by means of remotely operated systems. In this way the time required for an inquiry is independent of the distance from the central booking office.

In the system employed by American Airlines, for example, each inquiry can be handled in ⅓ to ½ second, at the rate of up to 10 inquiries per second. In addition the capacity of the overall system has been increased to handle 1,000 to 2,000 flights per day for one to six months in advance. With the aid of the electronic system it is possible to state immediately whether a seat can be booked on the flight of interest to the passenger. At the same time information is automatically provided on what flights on the same routes, of the same class and on the same day have free seats. In this way the customer can immediately be offered alternative accommodation if the flight originally envisaged is booked solid.

An additional installation also provides information based on the very latest data. It processes, every 15 minutes, all incoming reports on weather, condition of aircraft, situation as regards connecting flights, wind and traffic control conditions. This information is then stored and is thus available at all times.

C. Automation in air traffic control

Despite the many aids which electronics has made available to air traffic controllers and pilots, the demands made upon the human operators in the traffic control service have grown to such an extent that in the long run extensive automatic systems will have to be introduced to provide surveillance of the air space.

The first large-scale computer installation for air traffic control use, an IBM 650 RAMAC built by IBM Germany, is in service at the Air Route Traffic Control Center in Indianapolis, Indiana. If similar equipment were introduced into the German air traffic control service, the following operational stages would be envisaged:

The first step would be the processing of flight plan, control and weather data and their appropriate presentation to the traffic control personnel, the second the calculation and printing of progress strips, and the third the automatic presentation of data at the control desks as a replacement for the conventional strip control system.

Three-dimensional presentation of the situation in the air space would be reserved for a later development stage, as would also the analysis of the situation. With the introduction of an automatic computer installation to meet these requirements, the traffic controller would move more and more into a supervisory role and would not be fatigued by routine duties, many of which are purely repetitive in nature. His activity would thus become more interesting and his capacity to handle the multitude of parallel functions would be greatly increased. This would appear to be indispensable when it is realized that even during the next ten years it will be necessary to observe and control 1,000 aircraft at a time, and this with aircraft with the following performance limits:

Speeds of from 60 to 1,500 m.p.h.;
Rates of climb or descent of up to 9,840 ft./min;
Altitudes of up to 58,000 ft.

Automation of the air traffic control service will not be fully successful until the weakest link in the communications chain—the transmission of information by voice radio—has been entirely eliminated. Here help is promised by automatic data transmission systems (data links). But as these systems require certain ground and airborne equipment, the first step must be to arrive at international agreement on these equipments. During the past few years there has been gratifying progress towards cooperation between the European air traffic control systems, and it is to be hoped that automation in air traffic control will make good strides and the experience gained with the first electronic computers will promote overall development.

*

The advent of jet transports requires that in all fields of aviation the widest possible use be made of the latest technical, economic and organizational discoveries. Indeed, their use will be essential if the jets are to bring all the benefits of which they are capable.

The Aims of Europair

By * * *, Paris

The heads of Air France, Alitalia, Deutsche Lufthansa, KLM and Sabena have met three times during the past three months, in Brussels, Paris and Rome, to discuss the results of the studies carried out by their respective companies into the most rational way of utilizing their heavy jet aircraft.

The giant four-jet transports of the Boeing Intercontinental and Douglas DC-8 category were originally designed for North Atlantic services and are less well suited to the requirements of routes with lower traffic density. The best case in point is that of the South and Central Atlantic routes, where good utilization of capacity could be obtained only at the expense of frequency of services. The heads of the five airlines have therefore been studying plans for coordinating the operation of their jets.

Traffic quotas . . . with all due reservations

One of the difficult questions under discussion by the participating airlines is that of allocating quotas in the total Europair traffic volume. As long as negotiations are proceeding, all parties are naturally very reserved in their public utterances on this subject. However, it is understood that the quotas adopted may be somewhere in the following range (figures given *with all due reservations*):

Air France	27 to 31 percent
Alitalia	15 to 21 percent
KLM	19 to 24 percent
Lufthansa	23 to 25 percent
Sabena	9 to 14 percent

After the Rome meeting of the Europair airlines, a usually well-informed occasional correspondent reported that the following quotas in long-range traffic (including North Atlantic, but excluding services of a predominantly national character, such as to the French Union or the Belgian Congo) were discussed: Air France 27.2 percent, Alitalia 20 percent, KLM 20 percent, Lufthansa 24.4 percent, Sabena 8.4 percent.

At the present time the share of the individual companies in the five airlines' total intercontinental traffic is as follows:

Air France	30 percent
Alitalia	10 percent
KLM	35 percent
Lufthansa	15 percent
Sabena	10 percent

If the above-mentioned quotas are accepted for Europair, this will mean that the "old established" airlines will have agreed to substantial sacrifices in order to give the "juniors", Alitalia and Lufthansa—who got a late start because of the war—a share commensurate with the economic importance of their countries. The new quotas would come into effect gradually, not becoming fully effective until 1970 or even 1975. In any case, the practical effects of Europair will not be felt before the 1960 summer timetables come into force, with the introduction into service of the new big jets.

So far Air France, Lufthansa and Sabena are reported to have agreed to their respective quotas, whereas KLM and Alitalia are still considering the matter.

The initial purely commercial cooperation envisaged may later be followed by technical cooperation.

The fourth meeting of the interested airlines was convened in The Hague at the end of April.

Secondly the object is to make long-distance air travel accessible to the greatest possible number of passengers, particularly European passengers, by giving them the benefits of the lower costs which the airlines can achieve . . . provided that rational use is made of the big jets' higher capacities. Inter-airline cooperation designed to reduce operating and sales costs must contribute substantially to the realization of this aim and reach a new class of customers for whom intercontinental travel has hitherto been too expensive.

The five companies, which may in future be joined by others if they so desire, are in the process of forming an operating unit whose capacity will be comparable to that of the biggest world operators, such as Pan American World Airways, Trans World Airlines or Aeroflot. Together, they can offer travellers services of a quality comparable to that of the bigger airlines, both in volume and frequency and in choice of connections between intercontinental and medium-stage services.

At the moment the cooperation envisaged within Europair is of a purely commercial and operational nature. It does not extend to the technical field. Existing companies will retain their complete autonomy, and aircraft will continue to bear their own national colours under the Europair emblem.

The formation of Europair as an international organization responsible for putting these ideas into practice raises complex problems. Legally, the organization is to be of an international character, but the divergencies in national legislation are so wide that the companies will have to feel their way forwards step by step. A working group of experts from the five airlines has been set up to study the legal aspects, and a second group will concentrate on the economic aspects of Europair. As these groups did not begin their work until a few weeks ago, it is not yet possible to say exactly what form Europair will take.

All that can be said with any certainty at present is that the new structure will enable the participants to coordinate their commercial activity, thus rendering it more efficient for the community and less costly to the individual carrier. The resulting concentration of activity should lead to a substantial increase in staff productivity and thus to a saving in personnel in relation to total traffic volume. This does not mean staff cuts, since traffic volume is expected to grow to several times that of the individual carriers' present volume.

On the contrary, the personnel of the companies concerned have much more to fear from the weakness resulting from the relatively small scale of present operations compared with those of the big carriers mentioned above. For the personnel and the airlines themselves, who will all have to make mutual concessions on the national level, the formation of Europair constitutes an insurance whose advantages promise to be vastly more substantial than the doubtless unjustifiable fear that the new structure will adversely affect their situation.

Being designed to benefit both the public and the participating airlines, Europair represents a positive step forward and is not based, as has been proclaimed in certain quarters, on the desire to compete with non-member companies. Europair is not being formed *against* its competitors, but *for* a given object, namely to achieve more economic operation.

At this point it should also be made clear that, although the governments of the countries concerned have been kept informed of the progress of these talks and have encouraged the airlines to work out the conditions of the proposed agreement, the creation of Europair is in no sense a political move. The association will be open to any other European airline with the required qualifications. And it certainly does not mean that existing pool agreements between participating companies and airlines outside Europair will be denounced, though pool agreements between member companies will have to be adapted to fit the new structure.

Finally it should be stressed that the agreements envisaged under Europair relate to both long-range services and to European operations.

The Long-Range Fleets of the Europair Companies

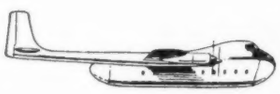
Aircraft	Airlines				
	Air France	Sabena	KLM	Lufthansa	Alitalia
Lockheed L-749 *Constellation*	16	—	10	—	—
Lockheed L-1049C/E/G/H *Super Constellation*	22	—	19	7	—
Lockheed L-1649A *Starliner*	10	—	—	4	—
Lockheed L-188A *Electra*	—	—	12*	—	—
Douglas DC-6/6A/6B/6C	—	13	14	—	11
Douglas DC-7C	—	9	15	—	6
Douglas DC-8	—	—	8*	—	4*
Boeing 707-320	17*	5*	—	—	—
Boeing 707-420	—	—	—	4*	—

* On order. Air France will take delivery of its first Boeing 707 in November 1959, Sabena in December, and Lufthansa in January 1960. On the other hand, first deliveries of the Douglas DC-8s for KLM will take place in early 1960, while the airline will receive four of the twelve Lockheed *Electra* turboprops on order by the end of this year.

WHY

RIDDLE airlines

CHOSE THE ARGOSY



More air freight is carried in the United States than in the rest of the world combined — so it is no wonder that the U.S. operators are more cost-conscious.

That is one of the reasons why Riddle Airlines Inc. have placed a provisional order for the Armstrong Whitworth 650 Argosy.

This major break-through in the dollar market is a tribute to the economics of this new British aircraft — the world's first pressurised turboprop freightercoach.

Mr. George L. Giles, President of R iddle Airlines, comments: " Apart from its lower direct operating cost, the Argosy will benefit the indirect expenses, due to lower handling costs . . . The AW.650 is the first aircraft to be designed and produced with this in view. With minimum reorganisation, the Argosy's quick loading and turn-round will save us at least 20 per cent on handling alone."

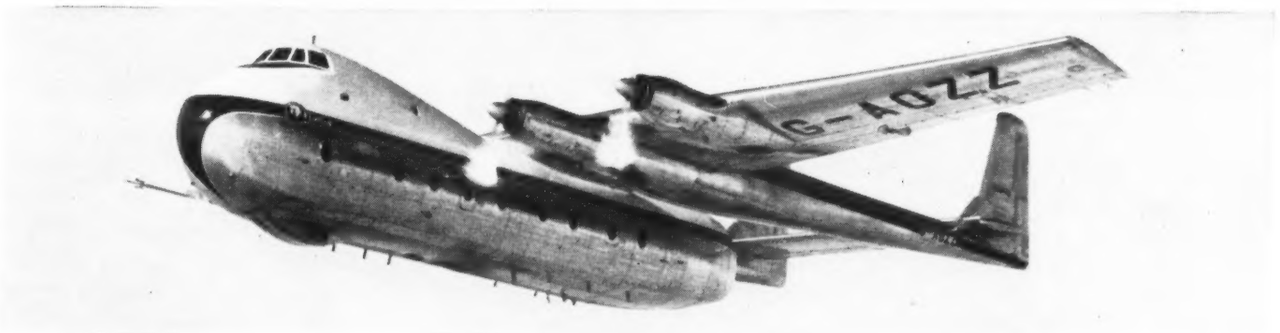
The Armstrong Whitworth Argosy offers cheaper freight rates because :

1. It is 30 per cent cheaper to operate than Riddle's existing twin-engined freighters.
2. The refined loading systems available with the aircraft, together with a full-width freight door at both ends of the fuselage, give rapid turn-round and help to reduce indirect costs to a minimum.
3. The Argosy is extremely simple to service — accessibility has been built in to the design — and it can operate from semi-prepared strips.
4. An extensive service organisation for many of the components — chosen for proven reliability — already exists in most parts of the world.
5. Coast-to-coast operation in the United States is possible within 24 hours, with only one traffic stop or as many as four.

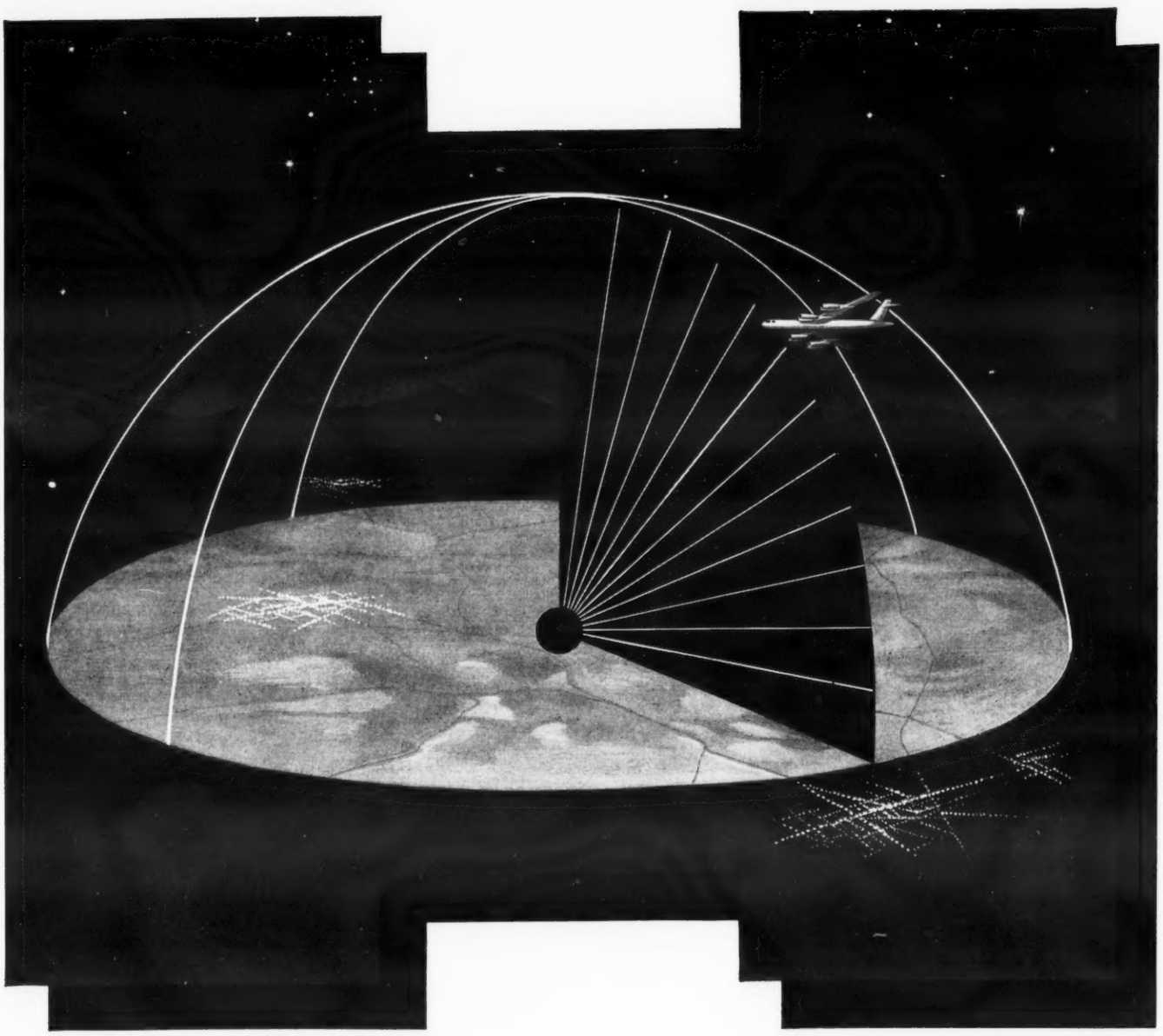
THE ARGOSY BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

HAWKER SIDDELEY AVIATION LTD

Richmond Road, Kingston-upon-Thames. *International Sales Office*, Duke's Court, St. James's, London, S.W.1.



The umbrella



that never leaks

TO ACHIEVE UMBRELLA-LIKE PROTECTION, Hughes Aircraft Company engineers have developed a three-dimensional radar system.

The unique frequency-scan radar antenna positions beams in space by electronic rather than mechanical means. This antenna is digitally programmed to instantly detect high speed enemy aircraft, even at low altitude. The one antenna gives range, height and bearing—simultaneously. Impulses from the radar antenna are relayed to data processors, which constantly feed information on hundreds of aircraft to control centers and provide for high speed assignment of defense weapons.

Hughes is distinguished for developing a number of "firsts"... including the first successful "weapons system" for interceptor aircraft. Hughes airborne control systems, now in use throughout the U.S. Air Force, literally fly the aircraft from take-off to touchdown. Integrated into this system are the deadly Hughes Falcon air-to-air missiles—both radar and infrared.

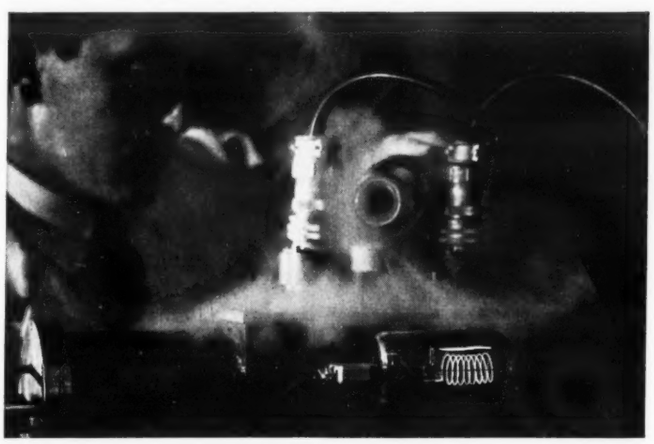
This amazing weapons system is but one example of Hughes capability. Other areas of Hughes activity include space vehicles, new special communications and telemetry systems, advanced guidance systems for ballistic missiles and integrated electronic systems for undersea warfare.

Hughes has over 30,000 people devoted to building advanced electronic systems. More than 5,000 engineers and scientists form the creative nucleus of this effort.

Throughout the entire Hughes organization, special emphasis is put on building reliability into every system to assure maximum utilization under the most severe conditions.

Advanced concepts... reliable hardware... these are the factors which have made Hughes one of the world's most respected electronics producers.

For further information please write to Hughes Aircraft Co., International Division, at the address below.



This Hughes scientist is shown with a Maser, an advanced device for eliminating static in microwave transmission. Other systems under study include Space Ferries, Global Surveillance Satellites, Meteor Communications, Satellite Interceptors and Futuristic Instrumentation Displays.

Falcon missiles have been an important factor in establishing Hughes as a leader in advanced airborne electronics. The two types of Falcon missiles (radar and infrared) can be carried by the same interceptor to give complete all-weather capability.

HUGHES

HUGHES AIRCRAFT COMPANY, CULVER CITY, CALIFORNIA, U.S.A.

STRÜVER Airfield Refueler
Capacity 10,000 Imp. gals.

A new type of fuel truck solves the problem of rapid and economical refueling for jet-powered commercial aircraft. Here are its characteristics:

Capacity: 10,000 Imp.gals. Delivery rate 750 Imp.gals/min.

Independent control of the individual delivery points through STRÜVER control valves.

Constant pressure at hose end even with varying flow strength. Control pressure can be pre-selected within a range of 20 to 50 p.s.i.

Accurate measurement of fuel quantity for both delivery and return.

Foolproof and rapid fueling, thanks to rational arrangement of fittings.

Corrosion-resistant, cantilever light metal tank, hence high payload.

Better water separation and shorter overall length through the STRÜVER patent double wedge shape of the tank.

STRÜVER HAMBURG
TANKWAGENBAU

AD. STRÜVER GMBH TANKWAGENBAU HAMBURG

...NEWS IS HAPPENING AT NORTHROP

N-156F DESIGN CONCEPT DELIVERS ECONOMY...MAXIMUM STRIKING POWER

To deliver maximum fighting power within the available defense resources of the free-world nations, Northrop has developed the new, multi-purpose N-156F – the Freedom Fighter. The supersonic N-156F is lightweight, takes advantage of new high-thrust-to-weight jet engines and uses less than half the fuel of comparable U.S. fighters.

In addition, this fighter offers unique logistic and technical advances. The N-156F can operate from short airfields or be adapted for zero-length launch. This mobility contributes to quicker reactions. It permits more aircraft on ready alert along a wider and more dispersed perimeter for maximum striking power–with minimum vulnerability.

Northrop's N-156F has been selected for development by the U.S. Air Force. It is the first supersonic fighter American-designed for specific tactical and economic requirements of other free-world nations. Designed for production outside the United States, the N-156F will make a substantial contribution to the economies of the areas it is designed to defend. *First Freedom Fighter now being manufactured will be flight-tested this year.*

NORTHROP INTERNATIONAL

BEVERLY HILLS, CALIFORNIA, U.S.A.
A Division of Northrop Corporation

TACTICAL FLEXIBILITY FOR SMALL AIRSTRIP OPERATION

TAKE-OFF: 400 YARDS
LANDING: 600 YARDS

PERFORMANCE

CLIMB	45,000 ft. (13,700 m.) IN UNDER FIVE MINUTES from Brakes-Off at operational weight
RADIUS OF ACTION	500 n.m. (950 km.)
LEVEL SPEED	M.98
MANOEUVRABILITY	RADIUS OF TURN at 45,000 ft. — 2½ n.m. (4.5 km.)
ARMAMENT	2,200 lb. (1,000 kg.) rockets or bombs plus two 30mm. guns

THE FOLLAND GNAT
INTERCEPTOR AND GROUND ATTACK LIGHT FIGHTER

Ordered by the Indian, Finnish and Yugoslav Air Forces
Two-seater trainer version chosen by the ROYAL AIR FORCE

FOLLAND AIRCRAFT LIMITED · HAMBLE · SOUTHAMPTON · HANTS

A Versatile Turboprop Airliner

The first flight of the *Vanguard* was in January this year. This airliner has now logged over 100 hours of the planned 1,500 testing hours in the air. Of the flight testing schedules so far completed the aircraft has already flown pressurized at heights of up to 26,000 feet and with speeds up to 370 knots: the highest take-off weight achieved so far has been 131,000 lb. (91 percent of the maximum). Deliveries of forty of these aircraft to British European Airways and to Trans-Canada Airlines (twenty to each) begin in early 1960.

*

With something approaching 400 *Viscounts* in operation, Vickers and Rolls-Royce say this pioneer turboprop paved the way for the *Tyne*-powered *Vanguard*. The makers worked very closely with BEA who had in the first place submitted a detailed specification requirement. Such an aircraft had to fly routes of up to 2,250 nautical miles and also the short hops from 200 to 600 nautical miles. This operational flexibility was to be combined with the facility to operate the aircraft as passenger, cargo, or mixed transport.

In what sort of conditions will the *Vanguard* be expected to operate on European and North American routes? A forecast of this was made by *Stuart G. Tipton*, as President, Air Transport Association of America, in April 1957[1]:

The airspace over airports will become more crowded in the years to come. Not only crowded but increasingly complex, for the air traffic control pattern of the future will include supersonic military jets, 550-mile-an-hour commercial jet transports, and 100-mile-an-hour helicopters—all at the same time and all desiring to land efficiently and safely."

As congestion on the world's air routes becomes worse it will be increasingly difficult for most aircraft to get a good flight clearance to cruise at their optimum altitude. If obliged to climb or descend from assigned altitude bands the economics of the pure jet will suffer accordingly. On the other hand, the ability of turboprop aircraft to cruise economically at any altitude specified by Air Traffic Control becomes more important. Over short haul routes particularly, the operational flexibility of the turboprop in heavy traffic areas makes it competitive with the jet on a block speed basis.

*

[1] Cf. "U.S. Airlines Anticipate Mass Travel by Turbine Aircraft" in *Interavia* No. 4, 1957, pp. 299–300.

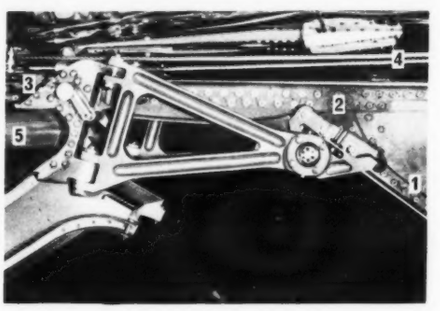
The *Vanguard* shortly before "launching" on its maiden flight from the Vickers airfield at Weybridge.

As mentioned above, the *Vanguard* was designed from the outset to have optimum short haul economics as well as the facility to operate the longer intermediate ranges. The fuselage chosen has a double-bubble section—passengers above, and freight in the holds below. The lower, pressurized bubble of this figure '8' cross section of fuselage contains two freight holds. These are big enough to carry maximum payloads using only one quarter passenger loads. This airframe feature cost Vickers 5 knots and 1,000 lb. of extra structure, but gives certain advantages:

- Night, or off-peak operation, in a cargo role without having to remove seats or insert partitions.
- On normal passenger flights low density freight, such as market produce, fashion garments, or small animals[2] (facilities are provided so that livestock may be carried in a heated section of the front cargo hold), can be carried.
- Two freight doors (5 ft. 6 in. wide) at truck-bed height let handlers work the cargo while passengers emplane on the *other* side of the fuselage.
- Handlers can secure or position cargo inside the 4 ft. 3 in. high holds, or "shunt" mobile freight bin-containers or the pre-loaded cargo pallets.

Passenger seating combinations of four, five and six-abreast arrangements are possible. Removable partitions, pantries, and "coat spaces" convert first-class or tourist-class layouts for high density coach services. The *Viscount*-type windows have a depth of about two feet.

Interesting design details of the Vanguard: Front view of a structural test specimen showing the unusually large freight compartments; the fully swivelling port two-wheel main landing gear which allows the aircraft to "turn on its heel"; the large Fowler flap sections (5) are actuated by two sets of bogies (2 and 3), which are drawn along guide rails (1) by means of a cable system (4) . . . the flaps move downwards and aft.



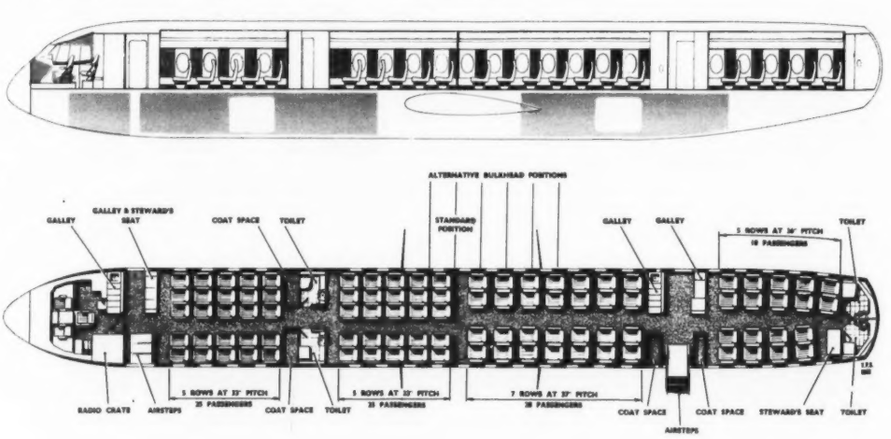
Some design features

Engines and propellers: The four two-shafted *Tynes* of 5,525 e.h.p. each, are fully interchangeable. They drive four-bladed de Havilland propellers of 14 ft. 6 in. diameter which besides revolving at the same speeds maintain constant blade angle relationships one with the other. This *phase synchronization* plays an important part in reducing noise and vibration to a minimum. The low fuel consumption of the fifteen-stage, two-spool, axial-compressor *Tyne* is comparable with the more economic piston engine. The de Havilland propellers are coupled to the "low-pressure" shaft through a compound epicyclic reduction gear. Reverse pitch braking permits the pilot to shorten landing runs and ground manoeuvre the aircraft. With the aircraft parked, the propellers are prevented from windmilling by means of parking brakes fitted to the gearboxes. For taxiing or ground checking purposes when the flying controls are locked, a "nuisance bar" safeguard on the throttles permits the pilot to open the throttles of only two engines at a time (one port and one starboard) up to take-off power.

Rotol accessory gearboxes are mounted below the engines in each nacelle. Each inboard gearbox drives a cabin blower, an alternator, and a hydraulic pump; each outboard unit drives two alternators and a hydraulic pump. A complete power unit (with or without propeller) may be removed from its nacelle without disturbing the engine-driven accessory gearbox.

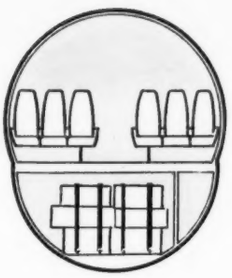
The flying controls are entirely manually operated (hand and foot forces or automatic pilot) with conventional manual trimming. The ailerons—each divided into three sections to allow for wing flexing—are not directly coupled as each is operated by a spring tab. There are four sections of Fowler flap on

The standard mixed-class layout 96-seater for Trans-Canada Airlines.



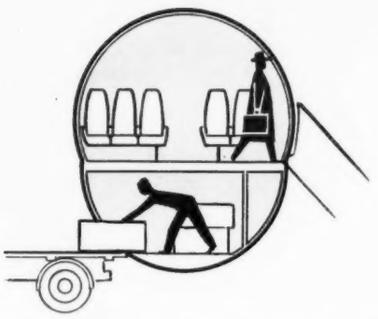
[2] According to PAA, *Clipper* Cargo in one year carried 9,000 monkeys (for delivery to medical research centres) and some 7,000,000 chicks, besides shipping Hawaiian orchids to the USA. Model gown collections are flown from Paris and Rome direct to New York simply hung on racks and enclosed in cellophane bags.

The *Vanguard* can operate with a full payload even if only 25 percent of the passenger seats are occupied – the payload is "topped up" by freight, which ensures very economic operation.



During off-peak periods, e. g., at night, the *Vanguard* can be operated as a pure freighter without removing passenger seats or in any way interfering with cabin fittings.

Even when the passenger cabin is fully occupied, there is still capacity for low-density freight, such as model gowns, unpacked ready-made clothing, flowers, market produce or small animals.



Freight can be loaded and unloaded speedily, without hampering passenger movements thanks to the large doors at truck-bed height and the adequate headroom (4 ft. 3 in.) inside the freight holds.

each wing. They are mounted on bogies which ride fore and aft on steel guide rails. The bogies, together with flaps, are actuated by a cable system driven from a rotating shaft, powered from a single hydraulic jack in the starboard inner wing. Safeguards are provided to obviate asymmetric collapse of the extended flaps in the event of a shaft or cable failure.

The integral fuel tanks are pressure refuelled for a 1,500-mile flight in six minutes. The 6,120 U.S. gallon fuel system can also be defuelled at a rate of 240 gallons per minute. Provision is made for rapid fuel jettisoning.

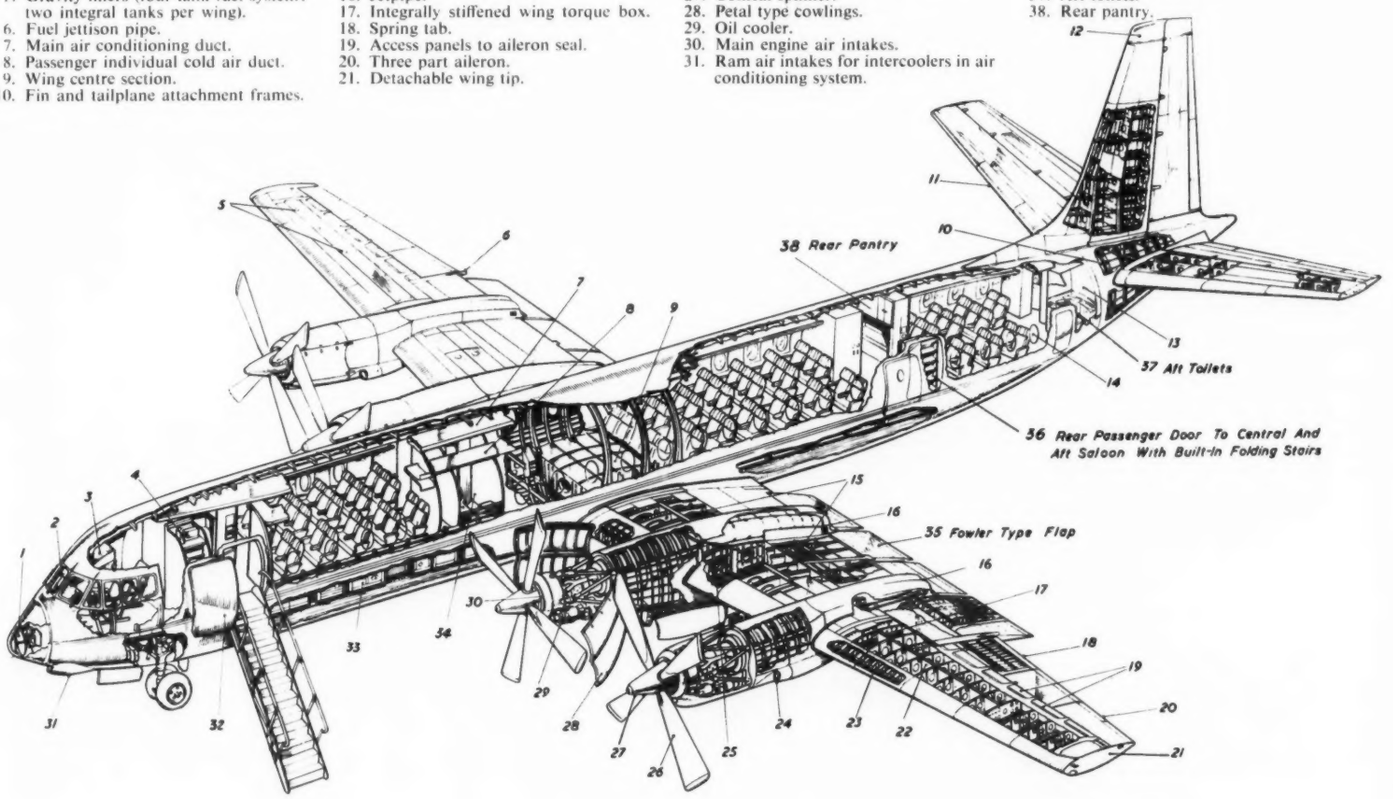
The main undercarriage retracts forwards into the inner engine nacelle housings. Emergency lowering is by the combined effects of gravity and air drag forces on the exposed gear. The *Vanguard* pivots about one main leg on its side-by-side twin wheel units, and although the wing is some way behind him the pilot can easily see its tip.

The aircraft systems are balanced between the use of hydraulics and electrics. Hydraulic power is used for undercarriage retraction, flap operation, nose-wheel steering and brakes, propeller brakes and the passenger steps. The hydraulically operated nose-wheel is steered from either of two handwheels in the cockpit. Fuel valves and the undercarriage selector valve are electrically operated, and there is an electrically driven auxiliary pump in the hydraulic system in addition to the four engine driven pumps.

Pressurization of the entire fuselage, less only the tail cone, nose-wheel and nose radar bays is to a maximum differential pressure of 6½ lb. per square inch (0.46 kg/cm²). Two Godfrey blowers – mounted one on each inboard engine – are used to supply fresh air for pressurization and air conditioning. Either blower can maintain full pressure if

Cutaway drawing of the four-turboprop Vickers Vanguard

1. Radome over cloud and collision warning radar.
2. Electrically heated and demisted windscreen panels.
3. Air supply duct to flight deck.
4. Radio crate.
5. Gravity fillers (four-tank fuel system: two integral tanks per wing).
6. Fuel jettison pipe.
7. Main air conditioning duct.
8. Passenger individual cold air duct.
9. Wing centre section.
10. Fin and tailplane attachment frames.
11. Electrical de-icing (Napier Spraymat).
12. Dielectric fin tip incorporating the VHF and VOR/ILS aerials.
13. Rear pressure bulkhead.
14. *Viscount*-type windows (26 × 19 in.).
15. Access holes to integral tanks.
16. Jetpipe.
17. Integrally stiffened wing torque box.
18. Spring tab.
19. Access panels to aileron seal.
20. Three part aileron.
21. Detachable wing tip.
22. Wing centre web.
23. De-icing hot-air duct.
24. Air intake to de-icing heat exchanger.
25. Main undercarriage machined rib.
26. 14 ft. 6 in. diameter trapezoidal planform de Havilland propellers.
27. Conical spinner.
28. Petal type cowlings.
29. Oil cooler.
30. Main engine air intakes.
31. Ram air intakes for intercoolers in air conditioning system.
32. Forward entrance door with built-in folding stairs.
33. Forward underfloor freight hold.
34. Toilets (port and starboard).
35. Fowler type flap.
36. Rear passenger door.
37. Aft toilets.
38. Rear pantry.


38 Rear Pantry
37 Aft Toilets
36 Rear Passenger Door To Central And Aft Saloon With Built-in Folding Stairs
35 Fowler Type Flap

Technical Data for the Vanguard Mk. 2

Dimensions

Span	118 ft.
Overall length	122 ft.
Height	34 ft. 11 in.
Wing area	1,529 sq.ft.
Max. usable cabin floor area	893 sq.ft.
Max. usable cabin volume	5,690 cu.ft.
Max. cabin length	90 ft.
Max. internal width	128 in.
Max. internal height	86,5 in.
Volume of freight holds	1,360 cu.ft.

Weights

Basic operational weight empty (including crew of 7 plus removable catering allowance)	83,500 lb.	
Total fuel weight	40,800 lb.	
Max. payload	29,000 lb.	(64,000 lb.)*
Max. take-off weight	141,000 lb.	(166,000 lb.)*
Max. landing weight	121,000 lb.	(153,800 lb.)*
Max. zero fuel weight	112,500 lb.	(142,800 lb.)*

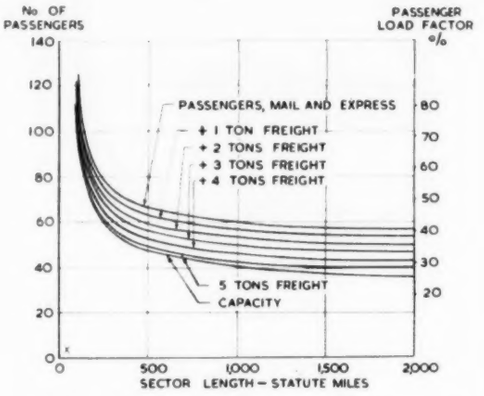
Powerplant (four **Tyne RTy.11s**)

Rated take-off power (at 15,250 r.p.m.)	5,525 t.e.h.p.
Specific fuel consumption (cruise, 13,500 r.p.m.)	0.388 lb./t.e.h.p./hr.
Total fuel	6,120 U.S. gals
Diameter of de Havilland propeller	14 ft. 6 in.

Performance

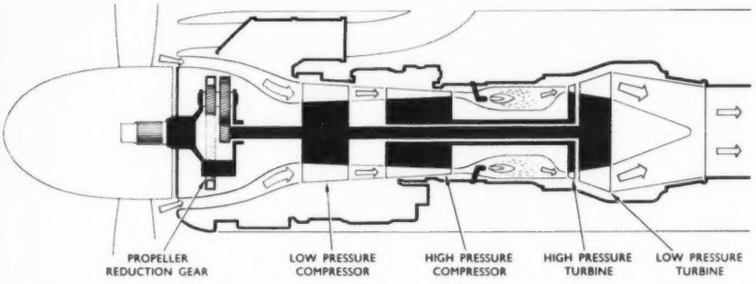
TAS cruising speed at 20,000 ft. for 121,000 lb.	367 knots
Take-off balanced field length (max. take-off weight) at sea level under standard conditions, based on USA SR 422 requirements	6,000 ft.
Landing field length (max. landing weight) at sea level under standard conditions, based on USA SR 422 requirements	3,500 ft.
Range with 17,000 lb. payload, 40,800 lb. fuel, at 350 knots (mean) up to 30,000 ft., zero headwind, no reserve fuel	2,920 n.m.
Range with full payload of 29,000 lb., zero headwind and no reserve fuel	1,740 n.m.

*Vanguard Proposal "B" freighter version.

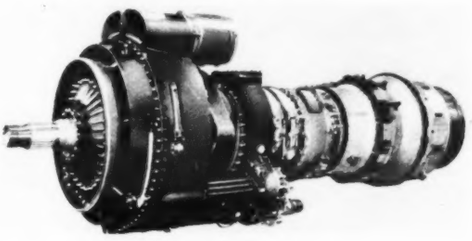


Number of passengers (i. e., passenger load factors) required to break even in the Vanguard Mk. 2, *assuming a complementary freight load (parameter, in long tons), plotted against stage length (abscissa, in statute miles).*

Sectioned view of the Rolls-Royce RB.109 Tyne *two-spool engine.*



The Tyne *delivers 5,525 e. h. p. on take-off.*



required. The cabin air is completely changed approximately twenty times every hour.

Wing de-icing is by ram air passing through two heat exchangers (heated by engine exhaust gases); the heated air then passes along the double skin of each mainplane leading edge to outlets at the wing tips. The tailplane and fin leading edge incorporate Napier electrical cycling heated surfaces—the "Spraymat" System; propeller spinners and air intakes to the engines are also electrically deiced. The power for this is obtained from two engine-driven alternators.

For ground servicing, many of the more frequently used doors and panels are designed to open and close without the use of special tools. In fact, it has been made possible for ground servicing teams to do much of their more routine trouble shooting in very cold weather conditions while wearing gloves or mittens. The engine cowlings—readily detachable for ground run purposes—have self-locking, toggle-type fasteners which enable them to be easily closed by one ground mechanic.

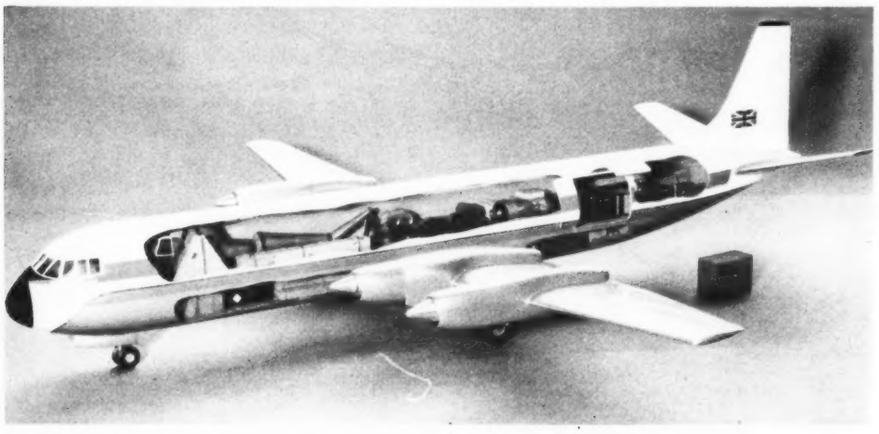
*

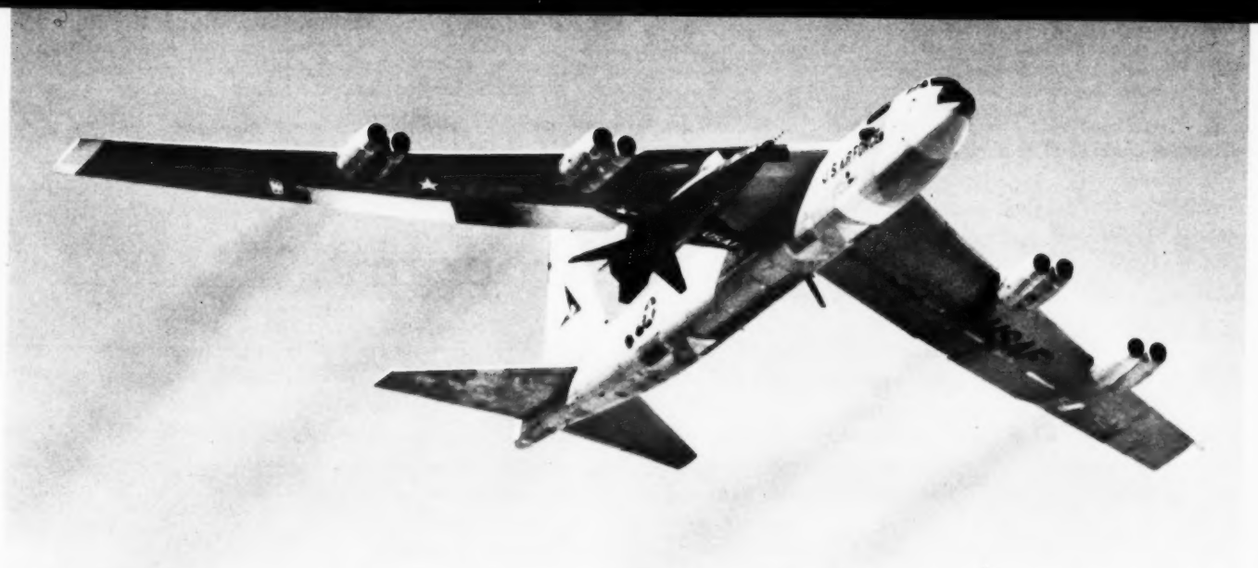
Apart from the present passenger versions, several freighter proposals (i.e. "pure freighter" transport) are also being examined by Vickers. "*Proposal B*" is of particular interest as it would carry a *maximum payload of 64,000 lb.* Considerable strengthening to the standard airframe would be necessary to cater for the higher weights involved. The floor would be suitable for general loading of 200 lb. per square foot (980 kg/m²), and two loading doors each nearly 10 feet wide would be provided. The freight capacity is shown in the illustration opposite.

*

Further technical details of this interesting design are shown in the various pictures and captions. Dimensions, weights and performance of the *Vanguard Mk. 2* are detailed in the table above.

Model of the "Proposal B" freighter version for a maximum payload of 64,000 lb.: the upper main freight hold would be roughly 88 ft. long and have a volume of 5,700 cu. ft.; the lower holds would have the same capacity as in the standard passenger model, namely a total of 1,360 cu. ft.



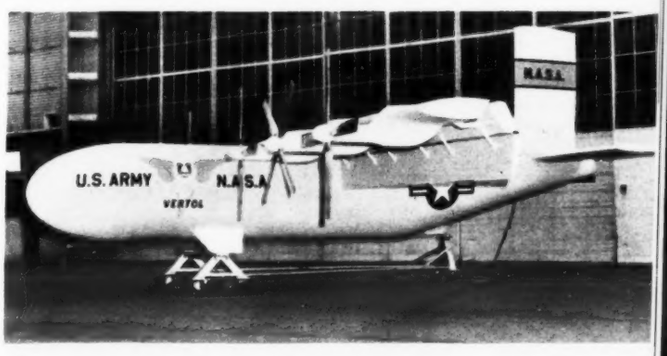


The North American X-15 completed its third captive flight at the end of March, when it was carried to an altitude of 38,000 ft. under the wing of a B-52 bomber. North American test pilot Scott Crossfield was at the controls of the X-15 which, as for the first test flight, was not released from the carrier aircraft. All equipment and systems, except the rocket engine, were operated by Crossfield to simulate actual free flight, and in order to be able to check the functioning of the fuel jettison installation, colourful dyes were mixed in with the jettisoned fuel during the test flight. More than 160,000 separate temperature recordings were obtained during the short captive flight to determine operating conditions of electrical, hydraulic and auxiliary power unit systems. In addition, thirty different temperature and aerodynamic readings were telemetered to the ground.

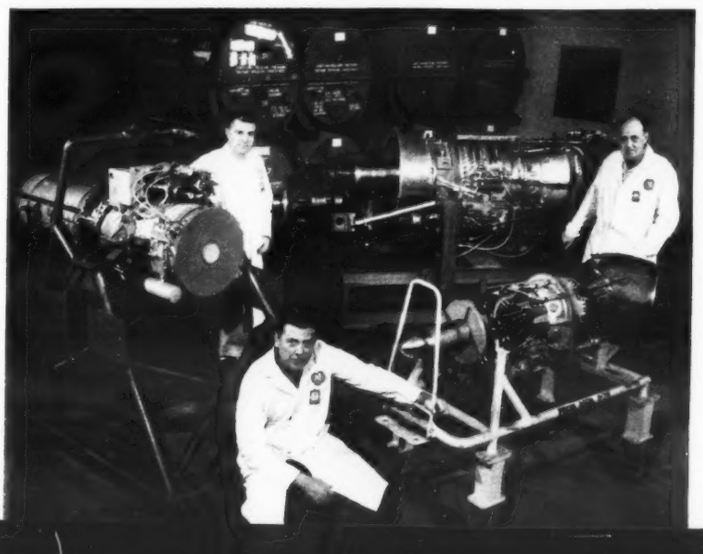
Progress in Pictures

Dornier, of Munich, began flight testing its Do 29 experimental STOL aircraft at the end of 1958. Derived from the well-known Do 27, the all-metal high-wing monoplane is powered by two Lycoming GO-480 engines, which drive pusher propellers tilting sharply downwards. The airfoil is similar to that of the Do 27, span is 43 ft. 3 in. and take-off weight 5,290 lb.

In conjunction with NASA and the U.S. Army Transportation Research and Engineering Command, Vertol Aircraft Corporation is studying the design of a 6-propeller tilting-wing aircraft for vertical take-off. The aircraft shown here was recently handed over to NASA's Langley Research Center for wind tunnel tests. The outstanding characteristics of the experimental aircraft are the extraordinarily large double-slotted flaps extending across the entire span of the wing. They occupy about half the wing chord, and on extension—with the forward wing portion horizontal—permit short take-off and landing with increased payload.



A new family of engines has been developed by the Small Aircraft Engine Department of General Electric Company, of Lynn, Massachusetts. Left, the small J85 lightweight jet in the 2,000 lb. thrust class; foreground, the 1,050-s.h.p. T58 helicopter gas turboshaft engine, and behind it, the new T64 turboshaft engine in the 2,600-h.p. thrust class. The J85 jet has been developed under contract to the USAF, and is intended to power the Northrop T-38 jet trainer and the McDonnell Green Quail decoy missile. The T58 gas turbine provides power for the Kaman HU2K-1, Vertol 107, Sikorsky S-61 and S-62 helicopters, as well as new Kaman and Fairchild STOL experimental aircraft. No installation use for the T64, developed for the U.S. Navy, has yet been named.



Space Astronomy

By Kurt R. Stehling[1]
Vanguard Division of the Space Projects Center (NASA), Washington, D.C.

The earth's atmosphere limits severely the potential seeing ability of optical telescopes and similar instruments. The atmospheric limitations are influential in two areas:

a) The attenuation of all, or some portions of the electromagnetic spectral emissions from heavenly bodies and

b) Image distortion caused by changes of refractive index in the atmosphere; this produces the well-known "scintillation" or "jitter" of optical images, which in turn smears images.

This latter effect is not too important for large light gathering telescopes, such as the Hale instrument on Mt. Palomar. These telescopes' importance is based on light gathered for spectrographical purposes without regard to image quality. On the other hand, when detailed image information is required, such as planetary and solar detail, and resolution of nebular and double star structure, the atmospheric limitations prevent even the large instruments from being much more effective than the smaller ones. Thus only part of the theoretical resolving power of large instruments can be used when these have to peer through the earth's atmosphere.

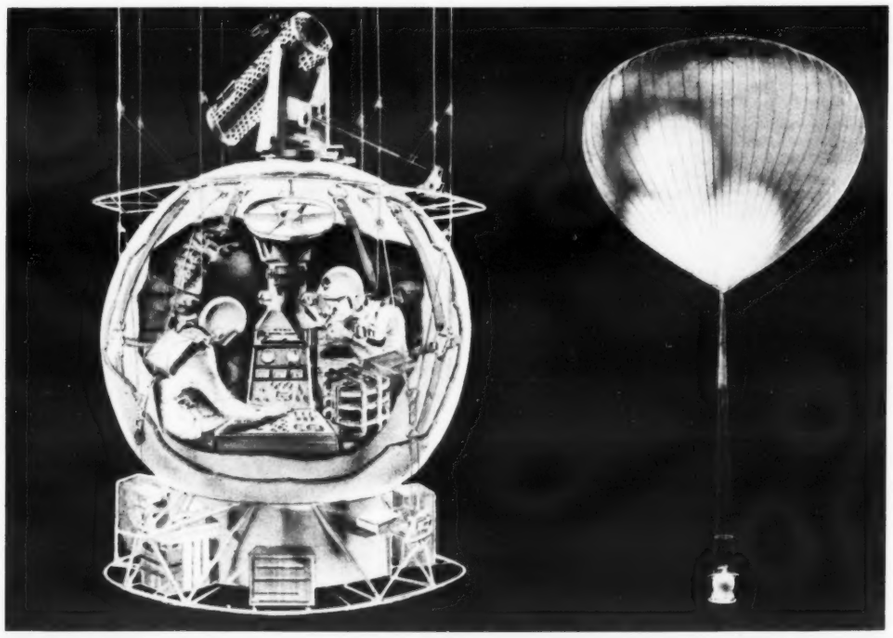
Radio astronomy during the past few years has opened up a new era of astrophysical research, since the atmosphere is transparent to most of the wavelengths used, and changes in density (or refractive index) disturb the radio waves only slightly; detailed resolution is at any rate not a requirement or possibility with present antennas. However, even in this area, man-made and natural electrical "noise" from atmospheric and high-altitude electrical phenomena interfere somewhat with the full potential of radio astronomy.

Optical astronomy must, of course, play a large part in astrophysics. The astronomers wish to obtain such detail as the grain structure of the sun's surface, planetary surface detail, spectroscopic information on planetary and cometary atmospheres, spectral information in the ultraviolet and certain infrared regions (the ultraviolet is presently heavily attenuated by ozone). – Thus, because of the previously mentioned atmospheric limitations much thought has been given to lifting optical equipment out of the atmosphere, or at least out of as much as can be done practically. One obvious answer is the placing of instruments on mountain tops which are reasonably accessible. The balloon has for many years been considered a practical vehicle for permitting high altitude research which would be unhampered by much of the atmosphere. Obviously a balloon cannot lift a payload beyond the atmosphere, but altitudes up to 120 or 140 thousand feet have been and can be attained. This would place a payload beyond 99 percent of the atmosphere. Early balloon experiments such as those of the U.S. Army's *Explorer I* and *II* in the mid-thirties and those of Professor Piccard in Europe were planned mostly for cosmic ray and atmospheric research. After the last war with the advent of cheap, lightweight plastic balloons, astronomers turned to this, now fairly readily available vehicle, as a possible tool for astronomy. During the last five years particularly, several important experiments have been planned and undertaken. Among these was the unmanned telescope capsule experiment organized by Prof. Martin Schwarzchild of Princeton University. This Princeton astronomer wanted more information on the "rice grain" structure of the sun's surface which had been noted only fleetingly at times and which was expected to show up when viewed beyond the lower turbulent atmosphere. This balloon launched to 82,500 ft. in 1957 did indeed return the telescope safely with many photographs of the sun obtained automatically and several of them showing startling detail not heretofore observed[2].

A balloon capsule is a "fluid" platform and a *man* on this platform (for manipulating telescopes) might complicate the observing picture by introducing oscillations. It must be emphasized that the astronomer's instruments require extremely steady supports. There is little purpose in

[1] The opinions expressed here are those of the author only.

Fig. 1: The Office of Naval Research "Stratolab IV" observation gondola built in 1958 for investigation of the Martian atmosphere had room for two men. It carried a Schmidt telescope, the light from which travelled through an opening in the top of the gondola to the observer's eyepiece on the central instrument column inside the gondola.



[2] This undertaking was called "Project Stratoscope". On September 25th, 1952 a 12-in. reflecting telescope was carried to 82,500 ft. by a large polyethylene balloon. The ascent took place near Minneapolis, Minnesota. The balloon hovered at this altitude for 4¾ hours; at intervals of one second, 35-mm photographs were taken continuously until about 8,000 frames were exposed.

Another successful flight occurred on October 17th, 1957. Again the 12-in. telescope (weighing about 1,400 lb. with accessories) was lifted to a height above 84,000 ft.

In 1956 some preliminary launchings occurred in Europe, carried out by E. D. Blackwell and D. W. Dewhirst, Cambridge University Observatory, in collaboration with A. Dollfuss, Meudon Observatory, France. They launched an 11-inch refractor to 25,000 ft. with a *manned* gondola. Good "rice grain" structure photographs of the sun were obtained.

In the United States, Prof. Schwarzchild has discussed a balloon observatory with a 36-in. telescope for observing planetary surface details and nebular stellar system structure.

Fig. 2: Nose section with photo-electric cells (in cylindrical portion) and antennas (on the lower edge), for a small high-altitude research rocket.

sending such instruments to high altitudes to eliminate the "jitter" of the atmosphere if the telescopic platform shakes.

Nevertheless with balloons now having payload capabilities of two to ten thousand pounds launched to above 75,000 feet, the inclusion of a human observer is not altogether impractical, especially for those observations requiring more than the rather routine manipulation which Schwarzchild needed, and where the viewing angle subtended is only a few seconds of arc rather than the large angle subtended by the sun.

In 1958 Dr. John Strong of Johns Hopkins University, Baltimore, supported by the Office of Naval Research, planned an experiment in which a 6,000-pound capsule was to be lifted to over 70,000 feet by a balloon with an experienced balloon pilot, Strong himself as the operator, and a specially designed telescope pointing through the vertical axis of the gondola *(Fig. 1)*. This important and historic experiment was planned to permit observation of the water vapor content of the Martian atmosphere, spectrographically, by observing the water vapor band in the ultraviolet spectrum of Mars. This cannot be done from the earth's surface because of the absorption of this band. Unfortunately, in late November, the low temperatures in North Dakota at the time of the planned balloon launching and the unusually heavy load ripped the plastic envelope and the balloon flight had to be cancelled. The ONR and JHU have hopes, however, of making other planetary observations during 1959 if funds can be obtained.

The coming of the missile and space age has opened up a new era of astrophysical research. During the IGY several satellite experiments in the United States and the USSR were designed to obtain cloud cover and cosmic information not obtainable in any other way. With the increase in the size of missiles came an increase in objectives, and astronomers who had looked rather pessimistically at early rocket programs now began to talk of establishing a new field of rocket astronomy up to and including the establishing of manned observatories and space stations and observatories on the moon.

The Naval Research Laboratory in Washington, D.C., with such workers as Dr. John P. Hagen, Dr. Homer Newell, Dr. Herbert Friedman, M. J. Townsend, Dr. Tousey, and others, has been a pioneer in the use of rocket-borne optical instrumentation. For some years *Aerobee*, *Viking* and war-surplus V-2 rockets served as carriers for solar spectrographs *(Fig. 3)*, cameras and various optical radiation detectors. It is possible to predict that later sophisticated astrophysical instrumentation with telescopes of several inch apertures can be included. Of course, since missiles will most likely follow the same growth factors as aircraft, one can prognosticate that in a few years manned space observatories can be established. For the moment, however, let us consider unmanned instrumented satellites and space probes.

*

The following are some of the problems that astronomers will surely encounter:

a) The obtaining of a reliable carrier rocket. While this is not the astronomer's problem, so to speak, he can hardly ignore it, for without the rocket there will be no rocket astronomy.

b) The packaging of instrumentation within the crowded confines of the front end of a rocket vehicle. This raises problems of heat balance, circuitry, and the "folding" of optical paths.

c) *Protection of sensitive electro-optical instrumentation* against vibration, aerodynamic heating, possible nuclear radiation damage in space and micro-meteor impact.

d) The *stabilization of the capsule* so that the movements of gyros, servo motors and mechanical elements will not introduce a long period of oscillation. This problem as noted before has been encountered with balloons and in several ONR "Stratolab" and USAF "Man-Hi" projects. Here the motions of the observers generated long-term oscillations consisting of low amplitude, low frequency and

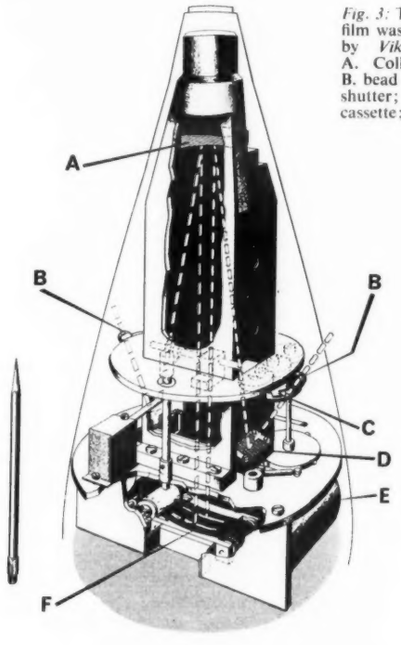


Fig. 3: This spectrograph with 35-mm film was used in high-altitude ascents by *Viking* and *Aerobee* rockets. A. Collector mirror with grating; B. bead lens (light entry); C. segment shutter; D. plane mirror; E. film cassette; F. film.

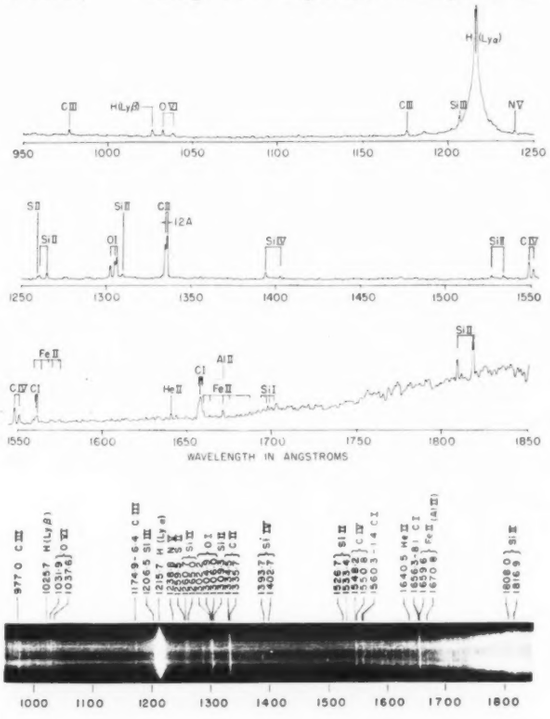


Fig. 4: Sun spectrum photographed from a rocket sonde at an altitude of 115 km. The test was carried out by the U.S. Naval Research Laboratory over New Mexico on February 21st, 1955. Wavelengths are given in Angströms (10^{-8} cm).

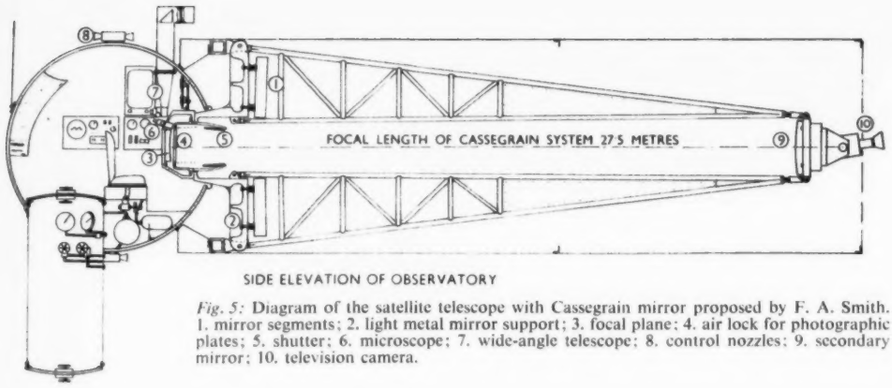


Fig. 5: Diagram of the satellite telescope with Cassegrain mirror proposed by F. A. Smith. 1. mirror segments; 2. light metal mirror support; 3. focal plane; 4. air lock for photographic plates; 5. shutter; 6. microscope; 7. wide-angle telescope; 8. control nozzles; 9. secondary mirror; 10. television camera.

some high frequency instabilities. A space capsule having no aerodynamic damping would probably have different modes of vibration and oscillations than a balloon-suspended gondola, but would still tend to oscillate about some center of action, probably indefinitely. By the use of fly-wheels, coupled to a referencing "lock-on" photo-detector and chemical jet reaction devices, such oscillations can be damped.

e) *Telemetry*. This latter obvious link is sometimes forgotten. It does little good to have a sensitive system of high resolving power if the information cannot be transmitted back to earth. It may some day be possible to recover films on which astrophysical data have been recorded; indeed an entire satellite or space probe could be recovered in this way. It seems more likely, however, for the moment, that astrophysical data will be telemetered back to earth. This requires a proper net of receiving stations, and command transmitters which will force the satellite recorder (either photographic or tape) to disgorge its information quickly by a suitable wireless link. There are severe requirements for reliability of the mechanical recording equipment and of the proper bandwidths to permit the display of the information obtained.

The corollary of the above is the orientation of the instrumentation either by ground command or, as said before, by photoelectric "lock-on". This very neat problem will surely occupy much of the astronomer's time.

When satellite payload capabilities increase, more astrophysical instrumentation can be carried. Initially, in payloads up to say 500 pounds, electronic telescopes may be used. For instance, it was recently announced in the United States that plans have been made for launching the first telescope into space with an unmanned orbiting vehicle containing 150 pounds of video telescope equipment. This video telescope will be designed to operate in the ultraviolet (i.e. beyond the 300 millimicron) region. It will be designed by scientists of the Astrophysical Observatory and the Harvard College Observatory, Cambridge, Massachusetts. The three project scientists, Dr. R. Davis, Dr. C. A. Whitney and Dr. F. L. Whipple, will manage the astronomical phase of the project.

It is estimated that a "four-color" map of the sky will be obtained by observations from the satellite for a period of about seven months. One of the important links in the project will be the ground receiving stations and computing centers. In fact, these links would of course be important in any astrophysical reconnaissance scheme. An example is the latest *Vanguard* launching of a cloud cover satellite. This satellite photoelectrically scans the surface of the earth, obtaining good contrasts between ground, water and land. However, the receiving of this data is only one step; the most difficult is the reduction of the same and

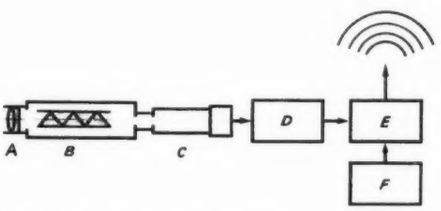


Fig. 6: Diagram of a small video spectrograph for use in satellites. The light collected by the collimating and focusing lens (A) passes through a multi-prism spectrometer (B) into the "Vidicon" video tube (C). The latter's electrical output signals are transformed and amplified in the video amplifier (D) and then radiated by transmitter (E). At the same time the transmitter also communicates synchronous position references obtained from a gyro or other horizontal reference sensor (F).

the final presentation in panoramic form on a video or oscillograph display.

Because the payload of the afore-mentioned telescope satellite is orbiting and because it contains large batteries, it can obtain a vast amount of data in its estimated seven months lifetime. On account of this lifetime a much greater return on the cost of the payload is obtained than from high altitude firings where spectrographic and other equipment is exposed to the desired environment for only a few seconds. However, it must be said that synoptic high altitude firings with reasonably cheap rockets are also necessary for certain spectrographic or magnetic research studies, since in that way a wider coverage of the sky is obtained above various points of the earth's surface, and also of course a wider altitude variation.

Some of these relatively modest beginnings will surely grow into more advanced space observatories. It is not impossible to conceive a manned observatory station some day at a high altitude (fairly permanent) orbit about the earth. In the March-April 1958 issue of the Journal of the British Interplanetary Society, F. A. Smith described a satellite telescope. This satellite, manned, would have a large reflector, with a mirror aperture of about 100 inches and a focal length of about 40 feet (see *Fig. 5*). The total weight of the mirror, auxiliary equipment, battery supplies, etc. is estimated by Smith to be only 8,400 pounds. Smith shows clearly that this telescope would be capable of enormous resolving powers, giving at its prime focus a lunar image 10 inches in diameter, and an image of Mars at visual conjunction of 1.5 inches. Smith also pointed out that by use of gas jets it is possible to maintain a proper attitude of the observatory; however, for fine control, fly-wheels driven by electric power would be necessary.

It is my opinion that the small perturbations set up by an observer in his inevitable movement in the capsule might create those very oscillations which are small but are the bane of the astronomers, and that these might be difficult to damp out. However, this does not detract from the striking merit of this approach, and provided that proper photoelectric lock-on devices are available and no thermal problems of heat conduction and capacity are met with, such a scheme may be feasible in a few years. However, I believe that ultimately for long-range and rigorous observations, a lunar observatory as described in "Aviation Age" of May 1958 is necessary. The moon, of course, being a most stationary platform and having possibilities of solar or nuclear power supplies and replenishing stations, forms a much more permanent and perhaps safer platform than does a space station.

To conclude then it can be said that with the advance in electro-optical and video data reduction technology and with the increase in the power and range of rocket vehicles, one can expect a wide range of space-astrophysical observations to be made, including solar and stellar spectroscopy in wavelengths presently absorbed by the atmosphere, and later planetary photography now not possible because of atmospheric turbulence.

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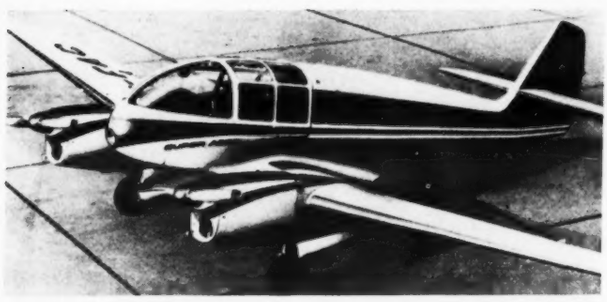

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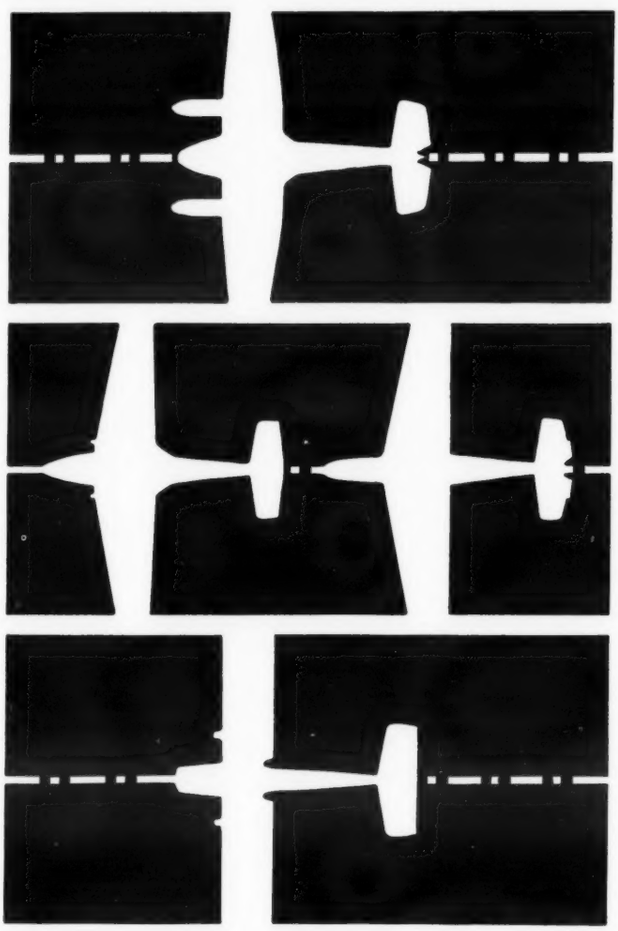

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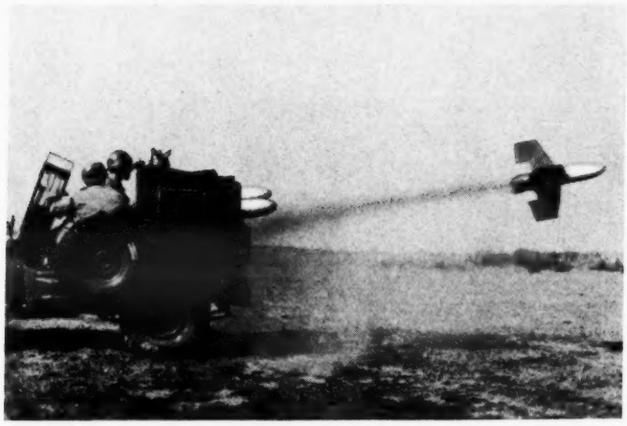

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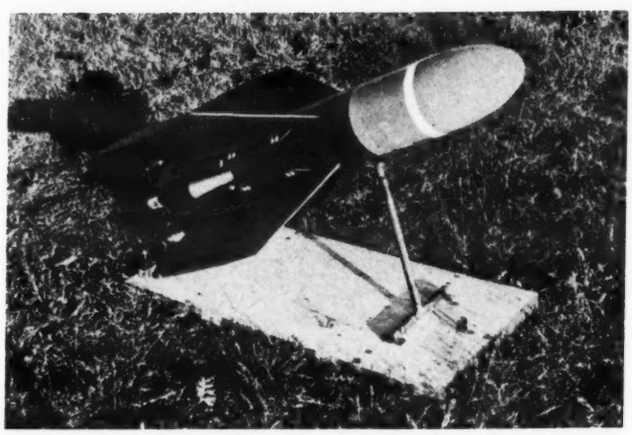

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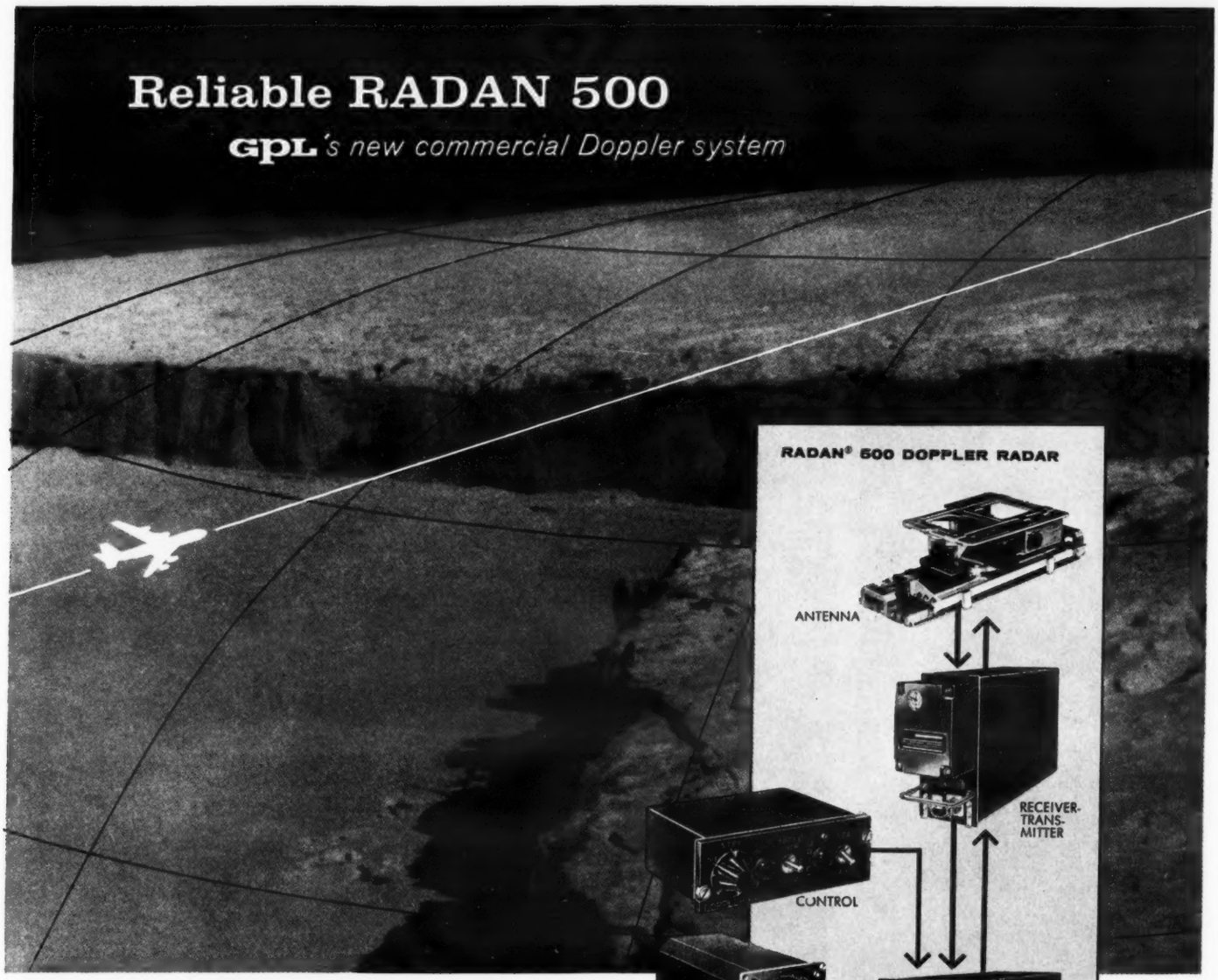

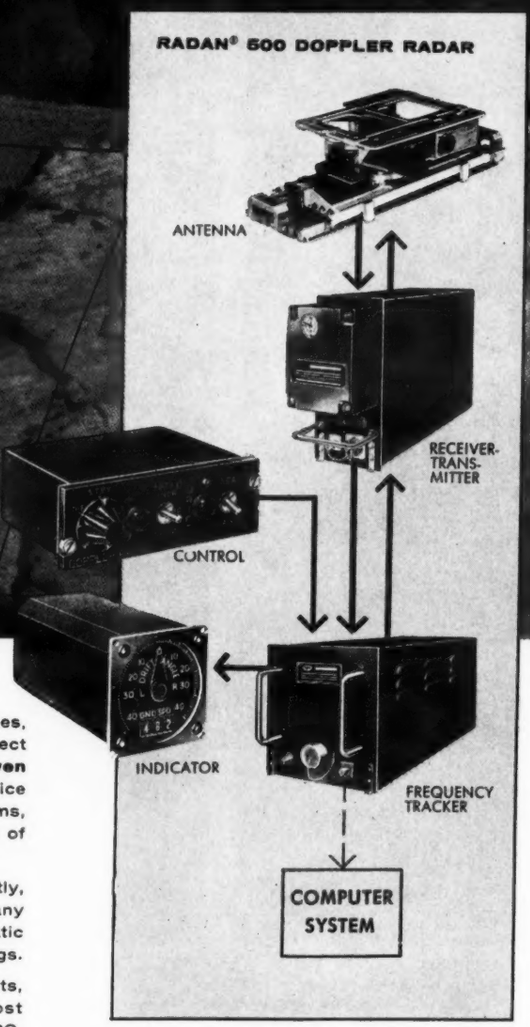

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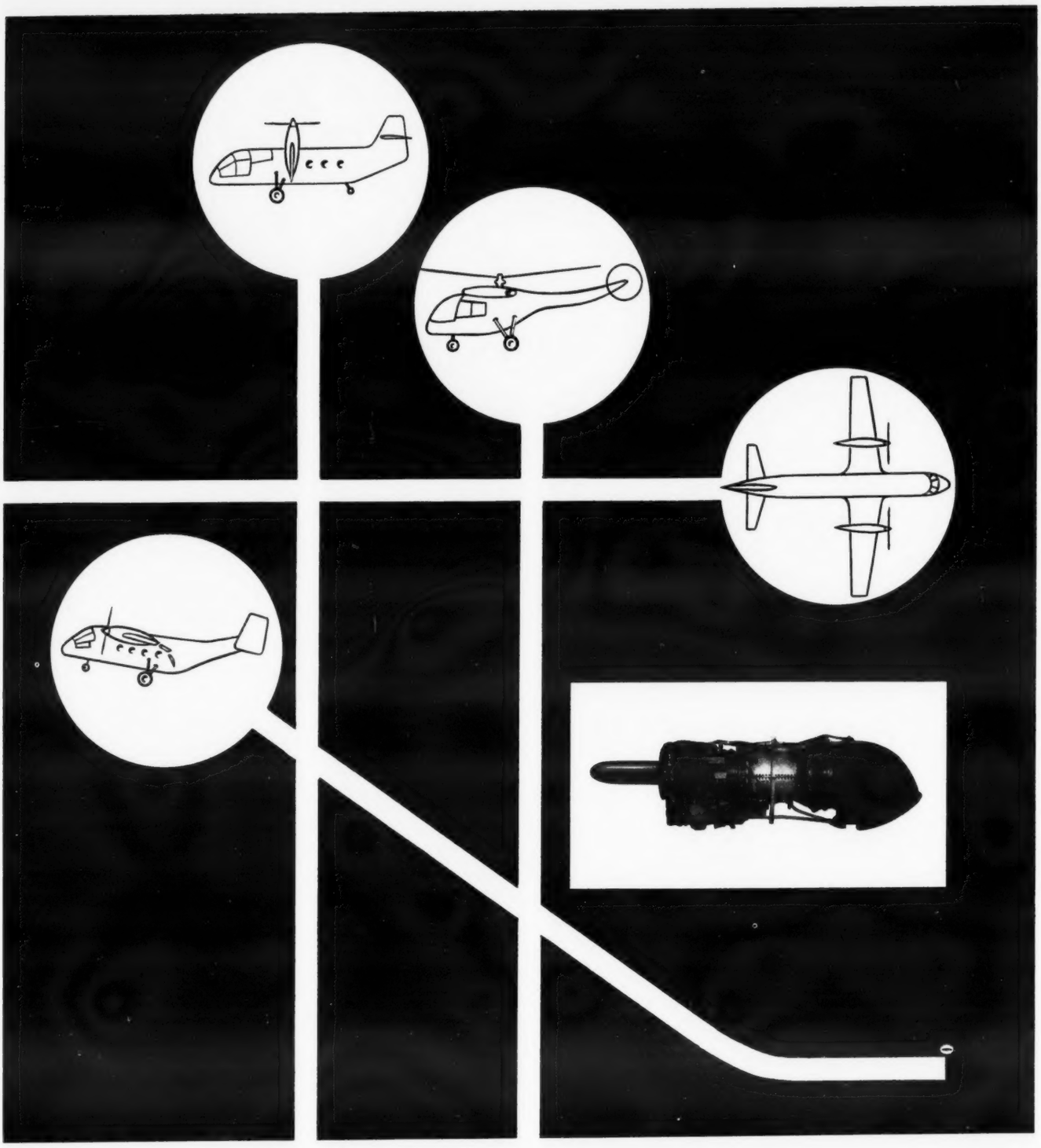

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Nuclear Tests in the Ionosphere

Summer 1958: Shortly after dawn one day last summer the USS *Norton Sound* experimental missile ship steamed out of the Californian Naval base of Port Hueneme. At this time none of the crew were aware that the 9,100-ton special ship was not making for one of its routine two-day voyages off the Californian coast, but would be gone for several weeks on a special mission in the South Atlantic. After a long trip round Cape Horn with complete radio silence, the *Norton Sound* was joined off the Falkland Islands in mid-August by eight other Navy vessels (including the 27,000-ton aircraft carrier USS *Tarawa*) to form Task Force 88, which then steamed on towards the northeast. The some 6,000 men of Task Force 88, all under the command of Rear Admiral Lloyd Montague Mustin aboard the carrier *Tarawa*, waited eagerly for what was to come.

By August 27th all was ready. In a choppy sea final preparations began aboard the *Norton Sound* for the launching of a 57-ft. Lockheed X-17 three-stage rocket, and six hours later the pencil-slim vehicle was racing vertically upwards into the ionosphere, carrying a streamlined body at its tip. After a few minutes a fireball flashed some 300 miles above the *Norton Sound* . . . the first task under Project *Argus* had been accomplished.

The explosion was followed up shortly afterwards by the launching of the U.S. satellite *Explorer IV*, which passed through the area in which the 1-kiloton nuclear warhead had detonated. At the same time too, dozens of rockets were sent up from the Task Force 88 escort ships and from land bases throughout the world to carry out measurements. The whole process was repeated on August 30th and September 7th, apparently undetected by the rest of the world. Again Lockheed X-17s were launched from the *Norton Sound*, carrying small nuclear warheads to altitudes of over 300 miles, and again the detonations in space were recorded by every conceivable kind of measuring equipment. The experiments conducted under Project *Argus*, maintained under strict security until recently, are considered to be among the most decisive and extensive scientific tests in history.

*

What induced the United States to undertake so costly an experiment? So far the Pentagon has released very little information on the significance of the tests, though Dr. Frank H. Shelton, Technical Director of the Armed Forces Special Weapons Project Office, defined the objects of the high-altitude detonations as follows: 1. to check important scientific theories about the earth's magnetic field; 2. to test high-altitude effects of military interest. As far as the first objective is concerned, the rocket measurements and the measurements carried out by the *Explorer IV* immediately after the *Argus* explosions supplied important information on the behaviour of the artificial radiation produced in the earth's magnetic field, and at the same time provided additional data on the natural radiation belt round the earth. The behaviour of the charged particles persisting after the explosions largely resembled the behaviour of the natural radiation stored permanently in the earth's magnetic field; within barely one hour the "electron plasma" had spread around the whole globe, with the exception of certain zones around the North and South Poles. The artificial radiation belt thus formed rapidly lost its energy, however, through collisions of the particles with vestiges of gas at the edge of the atmosphere.

Dr. Herbert F. York, Director of Defense Research and Engineering at the Pentagon, commented that the tests had been made to check certain theories put forward by Nicholas Christofilos, an atomic energy physicist. According to these theories, all charged particles entering the earth's magnetic field at a given angle and with a given energy can be trapped and stored by this field. Christofilos, who is currently working at the U.S. Atomic Energy Commission's Livermore Radiation Laboratory, had calculated before the first satellite measurements that elementary particles released by a nuclear explosion are trapped by the earth's magnetic field under certain conditions, so that it should be possible to determine the stability and life of these particles, the shape of the space they occupy and the gradual changes in this shape.

Complete silence has been maintained on the military side of the tests, apart from the significant remark by Dr. Donald Quarles, Deputy Secretary of Defense, that the experiments had yielded no information to suggest that the U.S. should change its approach to the *Nike-Zeus* programme. He declined to enlarge on reports that there had been considerable interference with radio communications and the operation of long-range radar. Nevertheless it would appear to be established that the cloud of charged particles left behind by the *Argus* explosions did in fact hamper the functioning of communications and radar equipment. This would mean that, *immediately before launching an ICBM attack, an enemy could cripple the defence machinery of the attacked country by means of nuclear explosions in space. At the same time there is the danger, not yet widely recognized, that the U.S.'s own A-weapons for defence against aircraft or missile attack could themselves disrupt the vital radio communications and radar equipment, required for an effective defence.* In view of these results, it is not impossible that certain modifications may be necessary to the costly Ballistic Missile Early Warning System and the *Nike-Zeus* control system, even if—Dr. Quarles added—the fundamental concept of radar detection and control remains unaltered.

Nothing has been said in official circles about the possibility of radically modifying ICBM defences, for example, by laying dense screens of particles (by means of nuclear explosions in space). Critical concentrations of elementary particles (particularly neutrons) could, it is believed, neutralize an enemy nuclear warhead or cause it to detonate prematurely. An *Interavia* correspondent reports from a reliable source in Washington that in this respect the *Argus* experiments were not altogether promising. It was also pointed out that ICBM nuclear warheads could be protected against interference by means of walls of neutron-absorbing materials, such as boron 10. Nevertheless, the *Argus* tests had supplied valuable information on the question of *how neutrons are trapped in the earth's magnetic field and how quickly their concentration in the explosion area diminishes.*

Although the three space explosions above the South Atlantic were apparently not detected by any foreign power, a Pentagon spokesman stressed that similar detonations in future could quite easily be recorded by satellites or rockets. This is a very important statement, in view of the United States' position at the Geneva negotiations on an inspection system to spot clandestine nuclear tests—a position which has been in no way affected by the results of the *Argus* experiment. Observation satellites with sensitive Geiger counters would be able—as demonstrated by *Explorer IV*—to detect and immediately report any experimental explosion in space.

*

While on the subject of the *Argus* project, mention should also be made of the space explosions above Johnston Island, in the Pacific, on August 1st and 12th, 1958, although there is said to be no direct connection between the Atlantic and the Pacific tests. In the Pacific experiments heavy nuclear warheads were detonated at lower altitudes than in the *Argus* series. These released large quantities of radio-active ions (short-lived isotopes) which, after decay, left countless neutrons behind. After the two explosions several radio companies and government agencies reported serious, long-period disturbances or a complete breakdown in radio communications in the 5 to 25 Mc/s frequency band. Also behind the Johnston Island test series was the question of how the debris of an explosion at the edge of the atmosphere behaves and what radiation densities are to be expected in the explosion zone. It is said that powerful explosions outside the atmosphere produce considerably more dangerous ionization radiation (500 to 5,000 röntgens per hour) than do explosions in the lower layers of the atmosphere. By comparison, a maximum of 10 to 100 röntgens an hour has been observed in the natural radiation belts.

It is an interesting point that the Pacific tests, which were known to all the Great Powers, almost coincided with the secret explosions over the South Atlantic. Originally both series of tests were planned for a later date, but were brought forward because of the United States' decision to suspend nuclear tests voluntarily on October 31st, 1958. Pentagon circles are now asking whether the Russians did not make similar experiments above the Arctic last autumn; for, on October 2nd, 1958, one day after the Americans suspended tests, the Soviet Government announced that it had resumed the testing of nuclear weapons. At the same time Western observation stations recorded two nuclear explosions which had presumably taken place near the territory of Novaya Zemlya.

At the present time all non-official predictions can only be of a speculative nature. Dr. Quarles explained the secrecy still surrounding the American tests by saying that "*it would not be in the national interest to release all of the information at this time*".

Rockets, Missiles and

• U.S. missile defences

The U.S. Defense Department has awarded a number of contracts in recent weeks for research and development of new systems of anti-missile defence. The project, a long-term research programme under ARPA control, is known as GLIPAR (Guide Line Identification Programme for Anti-Missile Research), and a spokesman has said that the initial research will involve at least ten contracts. However, it is not expected that any practical applications will be achieved before the 1970s. In the meantime the United States' main efforts in this field will be centred on the *Nike-Zeus* anti-ICBM defence weapon.

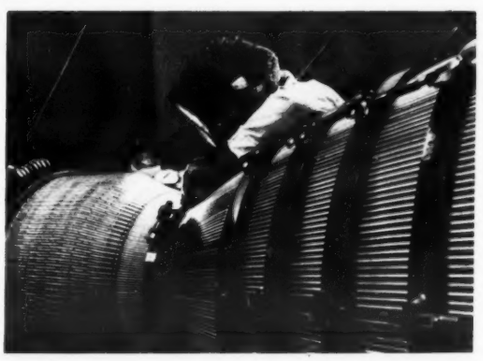
Meanwhile the North American Air Defence Command announces that the BMEWS (Ballistic Missile Early Warning System) currently under construction will have three long-range radar stations at Clear, Alaska and four at Thule, Greenland. The completed chain will have a 3,000-mile line of sight range. Enemy ICBMs would be spotted a few minutes after launching, so that the U.S. reprisal forces would have at least 20 minutes time for decision on a counter attack. Data from the BMEWS radar will be passed immediately to Norad headquarters at Colorado Springs, Colorado, and to Strategic Air Command headquarters at Omaha, Nebraska. Cost of the system to the USAF is estimated at roughly $ 1,000,000,000.

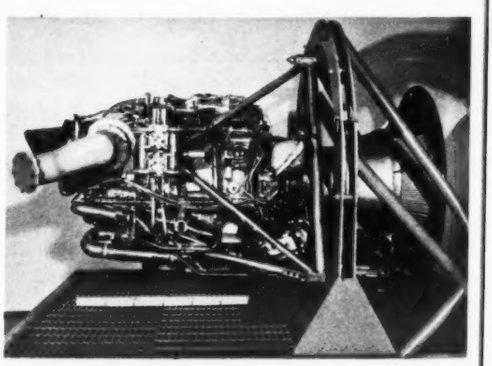
• The Atlas D ICBM, which went into production at Convair's Astronautics plant a few months ago, will have a range of roughly 7,500 nautical miles and will thus be capable of reaching any point in Eastern *bloc* territories from bases in the United States. A first *Atlas* with production-model nuclear warhead was launched over the South Atlantic in mid-March 1959. Meanwhile the Pentagon announces that the first squadron of ten *Atlas* missiles, complete with launching pads, will be operational at Vandenberg AFB, California, by June of this year. Of late the Air Force has been considering the possibility of placing three of the presently-planned nine *Atlas* squadrons underground, though this would require certain modifications to the missiles. In addition, a plan is being

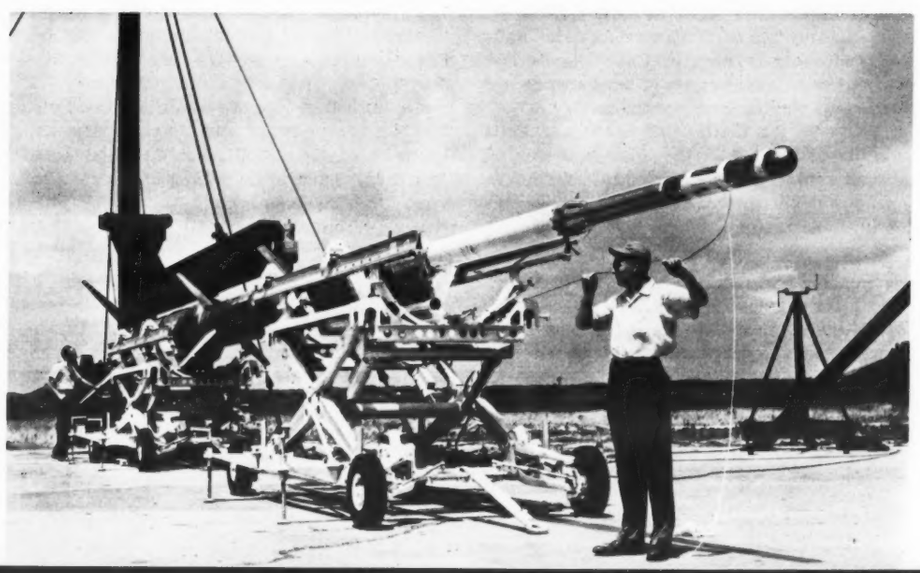
The liquid-propellant engines for the two-stage Martin *Titan* ICBM are under production at Aerojet-General's Sacramento plant. A particularly difficult operation is the heliarc welding and brazing of the many tapered stainless steel tubes used to make the thrust chamber. The tubes are positioned on a form and joined to produce a single component. As propellant flows through all tubes (regenerative cooling), the latter must also be interconnected by collector leads to carry off the preheated propellant.

This recently released picture of the XLR-99 liquid-propellant rocket engine developed by the Reaction Motors Division of Thiokol Chemical Corporation shows the compact configuration of the pump and auxiliary systems and the bell-shaped, sharply divergent nozzle. The engine, which delivers a thrust of 50,000 lb., will give the North American X-15 rocket research aircraft a speed of more than 4,000 m. p. h. and carry it to altitudes of above 100 miles. The XLR-99 can be switched on or off at will during flight, and its output is continuously adjustable.

A parabolic antenna with a 32 db antenna gain and a diameter of only 18 ft. (upper picture) together with a low-noise parametric amplifier with a bandwidth of 100 kc/s (below) enabled signals to be received from the U.S. *Pioneer IV* space vehicle over distances of more than 410,000 miles. The system, which works in the 1,000 Mc/s (L-band) region, was developed by the Heavy Military Electronics Department of General Electric Company and set up at the company's tracking station in Schenectady, N. Y. Apart from the Goldstone, California, station, which was operated by NASA scientists, it was the only installation in the United States capable of picking up satellite signals over so great a range. This was the first successful use of a parametric amplifier for the recording of very weak signals by the frequency comparison method, a General Electric engineer explained.

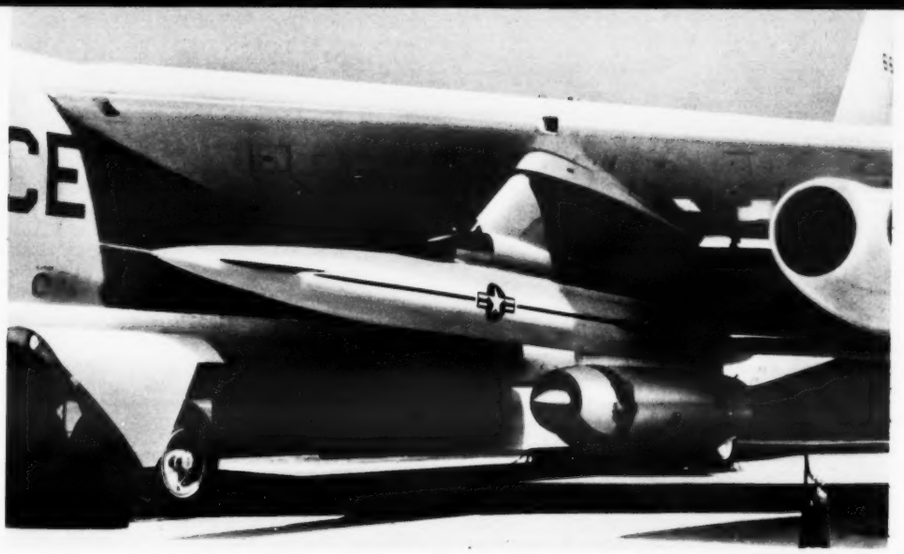






ARGO E-5 is the name of this five-stage high-altitude rocket developed by the Aerolab Development Company, of Pasadena, California. It can carry payloads of up to 50 lb. to more than 500 miles altitude: length 57 ft.; weight 7,000 lb. Acting under contract to the Air Force Special Weapons Center, the manufacturers supplied more than twenty ARGO E-5s, which were launched from a number of bases simultaneously with the high-altitude nuclear explosions over the South Atlantic (Project *Argus*), to carry out space measurements in conjunction with the explosions. The company was given only seven weeks to design, build and ready the rockets. As this schedule had to be maintained, use was made of existing solid-propellant rocket motors (such as *Honest John, Nike, Sergeant, Recruit*), combined to form new and efficient configurations. Other Aerolab rocket combinations bear the designations ARGO D-4 (to carry 50 lb. of payload to 1,000 miles altitude) and ARGO D-8 (to carry the same payload to 2,000 miles altitude).

Space Vehicles



This first picture of the North American GAM-77 *Hound Dog* air-to-surface missile shows the slender body, delta wing, delta vanes on the nose, and the nacelle for the Pratt & Whitney J52 jet engine mounted beneath the fuselage rear. Two versions of the GAM-77 are in production at the Missile Division of North American Aviation, Downey, California: a carrier for an A or H warhead of up to 1 megaton, and a carrier for electronic counter measures. The *Hound Dog* is designed for launching from the Boeing B-52G long-range bomber; its speed is reportedly more than Mach 2 and its range roughly 350 miles.

studied for procurement of an additional eight *Atlas* squadrons, which would have underground maintenance and launching installations. Under the plan the first two squadrons would be soft, with the missiles located in fixed towers. The next two would be placed on horizontal platforms behind revetments, and the next two again would be placed in semi-hard facilities (to withstand 25 p.s.i. over-pressure) on track-mounted platforms to permit them to be raised to the launcher. The remaining eleven squadrons would be placed in special silos, located vertically in the ground, from which they could be fired. All the underground weapons—as well as some of the others—will be equipped with all-inertial guidance systems.

● Progress on the WS-138A programme

The USAF's projected air-to-surface ballistic missile (earlier designation WS-199) for launching from long-range carrier aircraft is apparently making good progress. Judging by the results achieved in the ARDC's preliminary investigations and the free flight experiments so far carried out, a two-stage rocket with a range of 1,000 to 1,500 miles should be ready for operation in about two years. This could be carried by the North American B-70 supersonic bomber now under development, or by the existing Boeing B-52 and Convair B-58 bombers.

Companies participating in the preliminary experiments were Martin (together with Thiokol and General Precision Equipment), Convair (with Lockheed) and McDonnell. A forerunner of the air-launched ballistic missile, supplied by McDonnell, is reported to have been fired at Cape Canaveral on March 16th, 1959. In earlier tests Martin and Convair experimental missiles were launched from B-47 and B-58 jet bombers. Representatives of more than a dozen U.S. manufacturers also met at Wright Field in March to submit their projects for the WS-138A weapons system to ARDC.

● Juno II rocket motor

The first stage of the *Juno II* space rocket which propelled the U.S. *Pioneer IV* solar satellite ou its long journey, had the same powerplant as the standard *Jupiter* IRBM. On this subject the Rocketdyne Division of North American Aviation announces that the engine, built by the Neosho plant, has a ground thrust of 150,000 lb. and works on kerosene and liquid oxygen. The complete engine is gimballed, controls pitch and yaw, and gives the carrier vehicle the required directional attitude to put the satellite into its correct orbit. The bell shape configuration of the combustion chamber permits peak performance at both sea level and maximum altitudes. To provide cooling for the thrust chamber, fuel for the engine circulates through thin tubes forming the chamber walls before being fed through an injector into the combustion area (regenerative cooling). Twin pumps, spun by a turbine developing more than 2,500 h.p., force fuel and oxidizer through the engine at flow rates of approximately 4,400 gallons a minute. The turbine assembly is driven by hot gases provided by the combustion of the main propellants in a spherical gas generator. Exhaust from the gas generator, ducted overboard, is used to control missile roll. North American also announces that new versions of the rocket engine are under development, and these will be both lighter and smaller.

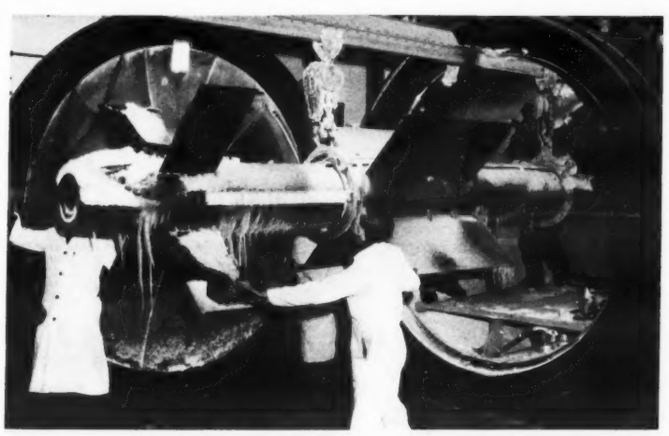
Certain features of the Rocketdyne liquid-propellant rocket engine installed in the *Thor* and *Atlas* are now being converted for use in the huge ARPA *Saturn* booster. This is being developed with the cooperation of the Army Ballistic Missile Agency and will comprise ten North American rocket engines, delivering a thrust of 1,500,000 lb.

● The U.S. National Aeronautics and Space Administration awarded contracts to a total value of $11,910,000 during the month of February alone; these were distributed as follows: McDonnell, $10,500,000 for the manned satellite gondola for *Project Mercury;* Minneapolis-Honeywell, $770,000 for the projected four-stage *Scout* satellite carrier vehicle; Smithsonian Institution, $470,000 for various electronic equipment; Aerojet-General $170,000 for powerplant for the *Scout.*

● The Centaur high-energy rocket engine under development for the U.S. space programme by the Pratt & Whitney Engine Division will have a thrust of 15,000 lb. Two of these units will power the second stage of NASA's *Atlas-Centaur* vehicle.

● Boeing manufactures improved Bomarc: Boeing Airplane Company has received a USAF manufacturing contract worth $300,000,000 for the production of a new version of the *Bomarc* long-range surface-to-air missile, with a range of roughly 400 miles and increased accuracy.

● A more advanced version of the Mace is to be developed, under a recent USAF decision. The Martin Company, as main contractor for the present TM-76B production model, has been awarded a $2,400,000 development contract. The older TM-76A version of the *Mace* will shortly replace the TM-61 *Matador* surface-to-surface missile now stationed in Germany.



Missiles in the refrigerator: extensive climatic tests which Armstrong Whitworth Aircraft Limited has carried out on its *Seaslug* ship-to-air missile included deep cooling in a refrigeration chamber (left). The weapon also underwent high-temperature tests, water and vibration tests, to prove its suitability for use aboard Royal Navy ships. On the new missile ships of the *Hampshire* class the *Seaslug* will be fired from a compact standard launcher (right) which was demonstrated to senior NATO officers a few months ago.

Fig. 2: Air transportable GTC 85 for the U.S. Navy, used to start fighters (in the rear a Douglas Skyray*) on land bases.*

Fig. 3: For use aboard aircraft carriers the GTC 85 is combined with a tractor. The equipment is seen here starting a McDonnell F3H fighter.

Fig. 4: Starting the eight jets of a SAC Boeing B-52 by means of compressed air from the AiResearch MA-1A starter cart.

Fig. 5: GTC 85 gas turbine compressor installed in the Lockheed C-130 Hercules.

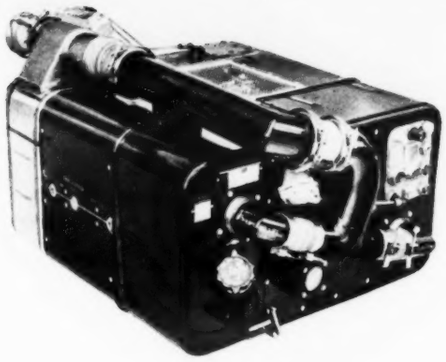


Fig. 1: AiResearch's first gas turbine compressor – the 1946 GTC 43/44 – resembled a suitcase in configuration.

Auxiliary Power for the Jet Age

The Garrett Corporation's Gas Turbine Compressors and Power Units

The Garrett Corporation's *AiResearch Manufacturing Division* in Phoenix, Arizona, has been called the world's largest producer of small gas turbine engines: to date the Arizona firm has produced more than 8,000 small jet engines with power ratings varying from 30 to 850 horsepower.

Development of the first AiResearch small gas turbine began in 1946. In design, the first unit, called a *Gas Turbine Compressor 43/44*, was an outgrowth of the centrifugal impeller of the AiResearch engine-driven compressors produced for cabin pressurization during World War II. It was a two-stage radial compressor and a single-stage radial inward flow turbine with an output of 50 air horsepower. Its configuration *(Fig. 1)* resembled a suitcase, and the complete auxiliary powerplant had its own internal cooling, oil, and automatic control system. It required only fuel from an external source and electricity from a battery and weighed 176 pounds.

Under a contract with the U.S. Navy Bureau of Aeronautics the first 200-hour qualification test was successfully completed in 1949, and the unit was installed on board the Consolidated XP5Y turboprop flying boat. Application of the airborne unit was to supply bleed air on the ground or in the air for starting and operation of accessories such as heating, refrigeration, anti-icing, and to drive an air turbine motor alternator. In 1950 production began on the GTC 43/44, and more than 500 units were produced for the Navy. One version of this series was built in an air transportable pod which could be attached to the underside of an aircraft wing and was used on the ground for starting Navy aircraft equipped with air turbine starters. Another feature was the use of the bleed air for ground de-icing purposes.

*

An entirely new compressor model series was developed under a research contract for the U.S. Air Force. Produced with various dash numbers, the GTC 85 series delivers air flow from 115 to 140 pounds per minute with air pressures of 105 to 115 in. Hg abs (3.6 to 4.0 kg/cm²) and air temperatures of 350 F to 450 F (180 C to 230 C). Operating limits of the new series are ambient temperatures from — 65 F to 130 F (— 54 C to 54 C); they can start from 0 to 20,000 ft. altitude and operate up to 30,000 ft. Starting time is from 15 to 25 seconds and weights from 185 to 225 pounds.

In 1954 two versions went into production. For the *Navy* the later GTC 85 replaced the 43/44 models in the pod form, and they were also mounted on tractors *(Fig. 3)* for use on board carriers for pneumatic starting. The *Air Force* version was adopted for use on the MA-2 ground support vehicle as a pneumatic power source. Then in 1955 AiResearch mass produced the GTC 85-20 and mounted the unit in a four-wheel trailer to serve as a MA-1A starter cart *(Fig. 4)* for the B-52, B-66 and the entire Century series of Air Force jet aircraft. More than 1,800 of these units have been produced to date.

In 1956 the GTC 85 unit was incorporated into the design of the Lockheed C-130 *Hercules* turboprop medium transport immediately forward of the left wheel *(Fig. 5)*. The turbine supplies pneumatic power for engine starting as well as power to operate the air turbine motor which drives the emergency hydraulic pump and a DC generator.

Installed in the Grumman *Gulfstream* executive transport is a GTC 85 with a 50 ampere belt-driven generator. Electric power from the generator starts the aircraft's engines, and the pneumatic power air conditions the cabin. Another executive transport, the Cessna 620, carries a GTC 50 for air conditioning and pressurization.

*

First use of AiResearch turbines as *prime movers* occurred in 1957 when McDonnell Aircraft Co. used three GTC 85-35 compressor turbines mounted in parallel on board their *model 120 pressure jet helicopter (Fig. 6)*. Compressed air from the turbine is ducted to pressure jet burners on the three rotor blade tips where fuel is injected, and the combustion gives the helicopter its propulsion. Exhaust gases from the turbine vented against rudders give the craft its directional control. Capable of flying on only two of the three engines, the

Fig. 8: GTP 70 in the main cabin of a Boeing KC-135 jet tanker.

Fig. 6: Three GTC 85s mounted in parallel provide power (and directional control) for the McDonnell Type 120 helicopter.

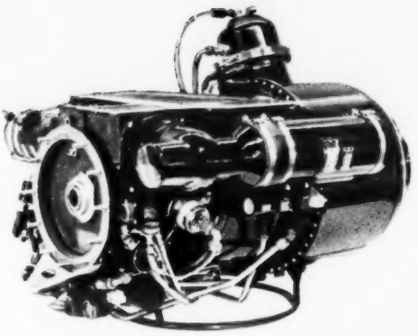


Fig. 7: GTP 70-10 gas turbine power unit for roughly 70 h. p. shaft power at constant speed; weight 160 to 195 lb.

aerial jeep has a maximum speed of 139 m.p.h. and a 3,000 ft. per minute rate of climb. The temperature of the turbine bleed air, 350 F (180 C) provides a built-in de-icing system.

*

A series of *shaft power turbines* were developed by AiResearch in 1950 and called GTP (Gas Turbine Power). Varying in models, they produce 30, 45 and 60 kW in generator sets. Their operating ambient temperatures are from — 65 F to 130 F (— 54 C to 54 C) and they can operate at altitudes up to 50,000 ft. Starting time is from 10 to 15 seconds and weight ranges from 160 to 195 pounds.

Between 1951 and 1953 AiResearch GTP 70 shaft power models *(Fig. 7)* were installed on board the Martin P5M, and the Lockheed R7V and P2V aircraft. During 1954 models were installed in the Lockheed C-121, the Convair T-29, the Douglas C-47, R6D and the Fairchild C-119F. Shaft power units have been installed on board the Vickers *Viscount 700 D* aircraft operated by private corporations in the United States. The airborne unit with two 500 ampere DC generators is housed in the tail section of the aircraft just aft of the pressure bulkhead. Weighing 175 pounds and capable of producing 100 horsepower, the unit supplies ground electrical energy to actuate the electrical starters and power to operate the freon air conditioning system.

GTP 70 shaft power units are currently installed in the cabin of the Boeing KC-135 jet tanker *(Fig. 8)*. They produce electrical power for instruments, lights, radio and radar; and the turbine's hot exhaust gases are employed through a heat exchanger to heat the aircraft while on the ground.

The smallest turbine produced by AiResearch is a 30 horsepower unit which weighs 45 pounds and is called a GTP 30 *(Fig. 9)*. As a power drive for generators, alternators, liquid pumps and compressors the unit is being used on ground applications and aircraft. It operates at altitudes up to 20,000 feet.

Currently in use for *missile ground support* are two AiResearch shaft power turbines. The GTG (Gas Turbine Generator) 70-2 is serving as a lightweight, portable electrical power source for *Sergeant* missile systems *(Fig. 10)*.

Fig. 9: AiResearch's smallest turbine is the GTP 30, which delivers 30 h. p. shaft power and weighs 45 lb.

Its output is available through a generator as 400 cycle AC current, some of which is rectified to DC. In support of the *Jupiter* missile complex a GTG 250 produces 100 kW power of 60 cycle electricity.

*

In 1954 a *combination compressor and shaft power unit* was developed. Called a GTCP 85, the unit supplies either pneumatic power or electrical power by means of an alternator or both simultaneously. Either electrical or pneumatic starting can be readily supplied from the one unit installed on a Navy tractor for carrier use. Operating ranges of the GTCP 85 are as follows: air flow output 110 to 140 lb./min; air pressures from 100 to 110 in. Hg abs (3.4 to 3.8 kg/cm²) and air temperatures 350 F to 450 F (180 C to 230 C). Shaft power with no bleed air is 100 to 250 horsepower. With a simultaneous load of pneumatic and shaft power the output, for an example, is 100 lb./min air flow, 108 in. Hg and 50 shaft horsepower. Ambient temperature ranges are from — 65 F to 130 F (— 54 C to 54 C). They start from 0 to 30,000 feet and operate up to 50,000 ft. altitude. Weight range is from 260 to 325 pounds. Current applications include the Martin P6M and ground support for commercial jet and turboprop aircraft *(Fig. 11)*.

An outgrowth of the GTCP unit in 1956 was the GTU (Gas Turbine Universal) which, in addition to having the dual capabilities of supplying pneumatic power and electrical power, can take main engine bleed air into its turbine section and allow the GTU's compressor air to be circulated for aircraft air conditioning. Two GTU units are installed aft of the left wheel well on the giant Douglas C-133 turboprop transport *(Fig. 12)*. All power requirements of the huge transport whether on the ground or in the air are satisfied by the two units, other than the main propulsion of the aircraft.

The latest combination unit to be developed by AiResearch is the *GTCP 105* which is currently being produced for ground support for the Convair B-58. The unit produces air flow up to 200 lb./min at 75 p.s.i.a (5.3 kg/cm²) or shaft power up to 850 horsepower. Two of the General Electric J 79 main propulsion engines of the B-58 can be started simultaneously by the GTCP 105 in less than 30 seconds. This larger unit is also under production in pod form for use by the Navy for their newer aircraft.

*

First use of AiResearch gas turbines for commercial jet activity was by *Eastern Air Lines* in 1958. GTCP 85-91 units are installed in panel trucks *(Fig. 13)* for the carrier's *Electras* and later for DC-8s. The units supply air for pneumatic starting and electrical power to operate the *Electra's* refrigeration and heating systems on the ground as well as for ground check of the radio, radar and hydraulic systems.

Other carriers using similar equipment or having such on order are Qantas of Australia, National, Braniff and TWA. Such starting carts in addition to the *Electra* and DC-8 are used for Boeing 707 and Convair 880 jet airliners.

Fig. 11: Starting an American Airlines Boeing 707 by means of a GTCP 85 starter cart.

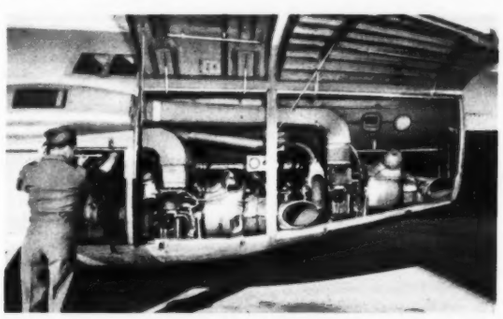
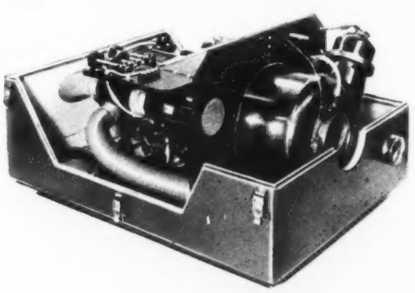


Fig. 12: Two GTU units are installed aft of the left wheel well on the giant Douglas C-133 turboprop transport. They supply all auxiliary power requirements of the aircraft, whether on the ground or in the air.

Fig. 13: An Eastern Airlines pneumatic-electrical starter truck ... and a Lockheed Electra.

Fig. 10: The portable GTG 70 gas turbine generator for missile ground support use.



What's in the Air?

Extracts from Interavia Air Letter, *daily international news digest, in English, French and German. All rights reserved.*

The future NATO headquarters at Porte Dauphine in Paris.

AIR TRANSPORTATION

● **Seaboard & Western Airlines** has applied to the Civil Aeronautics Board for cargo and mail rights on trans-Pacific routes from the United States East Coast, Mid-West and West Coast to the Far East and the South-west Pacific. Seaboard & Western's present fleet includes nine all-cargo *Super Constellations* and three all-cargo DC-4s.

● **Allegheny Airlines,** Washington, will test a Canadair/Convair 540 (Convair 440 with Napier *Eland* propeller turbines) on the Washington-Detroit route via intermediate points in Maryland and Pennsylvania to investigate the suitability of the turboprop powered aircraft on local service flights.

● **The Civil Aeronautics Board** has revised its procedural rules for conducting hearings into aircraft accidents and will bar representatives of damage claimants as parties to its investigations. The action preserves the Board's status as acting primarily for the Government's interest, and not as an agency to determine the rights or liabilities of private parties. CAB has pointed out that accident investigation proceedings are held solely for the purpose of discovering the facts, conditions and circumstances concerning an aircraft accident. However, the Board will permit interested persons to inspect data to be presented as exhibits at accident hearings.

● **Frederick B. Ayer and Associates** has contracted to purchase 45 Douglas DC-6 aircraft from American Airlines. Ayer has now contracted for the purchase of a total of 75 piston-engine aircraft from American Airlines.

● **Aeronaves de Mexico S.A.:** Negotiations for the take-over of Aeronaves by the Mexican Government have been finalized, and the company now becomes the first Mexican State airline. The cost of the transaction is reported to be 100 million pesos. General Manager Carlos Ramos remains in office pending the appointment of a successor by the Government.

● **Swissair-Photo A.G.** (a subsidiary of Swissair) is to extend its activities to include aerial survey work. This will include the aerial photography required for drafting topographical maps, and plans for construction projects such as dams, roads, town planning, land and forestry works, etc. These aerial surveys were previously carried out by Federal Land Survey and Ordnance Survey Services aircraft. The new activity of Swissair-Photo has called for a survey aircraft, the most modern air cameras, and adequate laboratory equipment. A single-engined Dornier Do 27 was delivered to the company at the end of March.

Professor Claude Dornier, Commercial Manager of Dornier, Friedrichshafen, celebrated his 75th birthday on May 14th.

Dipl.-Ing. Robert Lusser, Messerschmitt Technical Director for Development and Design, celebrated his 60th birthday on April 19th.

Air Commodore Malik Nur Khan has been named Managing Director of Pakistan International Airlines.

Inspecting a plaque in memory of William E. Boeing, founder of the company, in the lobby of the new Boeing Developmental Center in Seattle are (left to right) Mrs. W. E. Boeing, Sr., W. E. Boeing, Jr., and William M. Allen, President of Boeing Airplane Company.

● **The Belgian-Japanese air talks** have not yielded the anticipated results, and no agreement has been reached on the proposed trans-Arctic and trans-Siberian services via Moscow and Peking (as provided for in the Belgian-Soviet agreements). The Japanese authorities have only authorized the opening up of a route via the Near and Middle East and India.

● **An air committee** responsible to the Cabinet for defining civil aviation policy and for coordinating civil and military activities, has been set up in Portugal. Its powers will extend to questions of ground organization, purchase, manufacture and maintenance of aircraft, aeronautical activities (including operating licences), airports, telecommunications, air traffic control and air-rescue operations. The committee includes the Ministers of Defence, Finance, Marine, Foreign Affairs, Overseas Territories, Communications, together with the Under-Secretary of State for Air, the Chief of the Air Staff and the Director General of Civil Aviation.

● **Alfredo Queiros Vaz Pinto,** long-standing President of Companhia Portuguesa Radio Marconi, was appointed President of Transportes Aereos Portugueses at the end of March 1959. He succeeds Brigadier Joao de Freitas who resigned some three months ago because of his military commitments. Former director Duarte Calheiros is now Managing Director of TAP.

● **Italian fiscal 1959-1960** budget estimates for postal services include an amount of 2,300,000,000 lire for payments to Italian airlines for mail shipments. This is 200,000,000 more than in the current fiscal year.

INDUSTRY

● **Lockheed Aircraft Corporation** has launched an international expansion programme and announces the formation of a new subsidiary company, Lockheed

Flight testing of the first production-line Martin P6M-2 SeaMaster *naval patrol aircraft has been commenced. Powerplant: four P & W J75s.*

Britain's Prime Minister Harold Macmillan recently visited the RAF bomber base at Cottersmore, when the first picture of the production de Havilland Firestreak Mk. 1 *air-to-air missile was released. It is here shown on a Gloster* Javelin *all-weather fighter.*

Swissair-Photo A.G.'s activities now include aerial survey, and the firm has acquired a specially equipped Do 27 for this purpose.

Aircraft International, to provide aviation development programmes in foreign countries. Chairman Robert E. Gross said that several such enterprises were now in advanced stages of discussion between Lockheed and foreign countries and the task of the new subsidiary is to coordinate these programmes and to widen the world market for Lockheed products.

● **The Convair Division** of General Dynamics Corporation has been selected by the U.S. Air Force to undertake the initial design of a prototype nuclear-powered bomber (WS-125A) in association with the Nuclear Propulsion Division of General Electric Company. The USAF says the choice was made after study of preliminary nuclear aircraft design proposals submitted by both Convair and Lockheed Aircraft Corporation. The USAF will continue to support limited design work by Lockheed, including studies of radiation effects on airframe materials.

● **General Electric** is undertaking a growth programme for its 1,050 s.h.p. T58 gas turbine to bring it up to 1,250 s.h.p. Designated the T58—8, the project is financed by the Navy. On a test run with an initial version of the new engine, General Electric reported it achieved 1,350 s.h.p. and a fuel consumption of 0.574 lb./s.h.p./hr. The Navy is asking for 0.64 lb./s.h.p./hr.

● **Lockheed Aircraft Corporation** has acquired a controlling interest in the Puget Sound Bridge and Dredging Company in Seattle. Lockheed Chairman Robert E. Gross says that the company plans to take a part in building atomic submarines.

● **Boeing Airplane Company** had delivered a total of sixteen 707—120 jet transports to airline customers by early April: these were PAA six, American Airlines seven, and TWA three. Deliveries to other carriers are scheduled to commence: Continental (120s), and Qantas (120s), May 1959; Braniff (220s), October 1959; Air France (320s), November 1959; BOAC (420s) and Sabena (320s), December 1959; Air India (420s) and Lufthansa (420s), January 1960; Cubana (120s), March 1960; United (720s), April 1960; SAA (320s) and Varig (420s), July 1960; Irish Airlines (720s), November 1960. The total Boeing 707/720 order book stands at 190 aircraft.

● **Abel Tasman,** the first of twelve F.27 *Friendships* on order for Trans-Australia Airlines, was handed over to the carrier's representative at the Fokker Factory at the beginning of April. Other *Friendship* deliveries have been: five (of seven on order) to Aer Lingus, the remaining two being due for delivery in May; two for Braathens, and the third to complete the order in August; Ansett-ANA deliveries are scheduled for August, September and November, one in each month, and the final three in December. The six *Friendships* on order for Aviaco will be delivered in July (one), August (two), September (one), 1960 (two). The KLM and Philippine Air Lines F.27s (two each) are not due for delivery until 1960. Together with seven aircraft on order for industrial customers, and twelve for the Netherlands Air Force, Fokker's order book for the F.27 totals 57.

MILITARY AFFAIRS

● **The first Federal German Republic Battalion** to be equipped with Douglas/Emerson M-30 *Honest John* surface-to-surface missiles will have its peacetime base at Giessen (Hessen). Currently on the Eschweiler (Aachen) training ground are two launching ramps

Spain's Aerotecnica AC-14 five-seat helicopter, with 400 h. p. Turboméca Artouste II *gas turbine. Rotor diameter 31.5 ft.; max. speed 118 m. p. h.; service ceiling 22,310 ft.; hovering ceiling 16,080 ft. with ground effect, or 10,235 ft. without; range 280 miles.*

(Rock Island Arsenal), two transport vehicles and two practice rounds. The first operational missile is scheduled to arrive in Giessen during this summer. It is planned to establish nine Rocket Battalions equipped with 36 launching ramps and 288 missiles. The necessary equipment will be purchased by the Federal Defence Ministry in the United States.

● **The United States Air Force's** 124th Air Transport Group (MATS) will station the three Boeing 707 jet transports now on order at Andrews AFB. The USAF plans to use Baltimore Friendship International Airport for some long-range 707 operations during the summer. Friendship Airport's longer runways will be more suitable for take-off with full loads on hot summer days when the air is less dense. MATS' three Boeing 707s are scheduled for delivery in May, June and July.

● **The U.S.A.F.** has scheduled a $13 million expansion to the Duluth, Minnesota base, to commence July 1st, 1959, and to include construction of a *Bomarc* missile installation at French River. The new programme is in addition to the $7 million extension work carried out since July 1st, 1957. The annual cost of operating the base is $6,600,000.

● **A $30 million underground combat centre** for the North American Air Defense Command is to be built by the USAF in the Cheyenne Mountains near Colorado Springs, Colorado. This new NORAD nerve centre will be impervious to thermonuclear attack. NORAD headquarters and administration will remain in its present location in Colorado Springs.

● **The Royal Canadian Air Force** has ordered ten Grumman SA-16 *Albatross* amphibians for search and rescue operations. The order is valued at $6 million.

AIRCRAFT AND POWERPLANTS

● **Handley Page,** in cooperation with the Royal Aircraft Establishment, has made considerable progress on its boundary layer research programme, and the

Training West German troops for the American Honest John *artillery rocket. DM 44 million have been approved for the purchase of 36 launching ramps and 288 rockets.*

Sikorsky HSS-2 amphibian helicopter with two General Electric T58-6 gas turbines of approx. 1,050 s. h. p. each. The HSS-2 is in production for the U.S. Navy.

major problems of dirt, rain, and insect ingestion seem to have been overcome. The result so far achieved indicates a higher economy on a boundary layer suction equipped transport than was hitherto considered possible. As a result of recent work, Handley Page is likely to get the green light for the construction of a full boundary layer research aircraft, probably in small transport form.

● **BMW Triebwerkbau Gesellschaft mbH.** is to take part in the Air Show connected with the Hanover Fair (April 26th to May 5th, 1959) at Hanover-Langenhagen Airport, for the first time this year. Exhibits will be the Lycoming GO-480-B1A6 engine built under licence by BMW and the company's own BMW 6002 small gas turbine.

The Lycoming GO-480 engine is sufficiently well known in trade circles not to require description here. The BMW 6002 turbine is designed to power various equipment and machines, and delivers 50 shaft h.p.; the turbine wheel speed of 45,000 r.p.m. at full load can, if required, be reduced to between 11,000 and 3,000 r.p.m. by changing the gear ratio. Any of the normal commercial fuels can be used (kerosene, gasoline, diesel oil, etc.); consumption at full load approx. 66 lb./hr. Starting can be fully automatic, with electric motor and spark plug ignition. In the absence of electric current, the turbine can also be started by a hand crank. Other features: above a turbine wheel speed of approx. 10,000 r.p.m. an automatic regulator provides control of the required rev. speed. The unit is particularly suitable for powering portable equipment (air compressors, emergency power supplies, starting equipment and airborne power supply units).

The H-3 Kolibrie *ramjet helicopter, now in small-scale production at Nederlandse Helicopter Industrie N. V., was demonstrated to representatives of the Swiss Federal Defence Department and Federal Air Office at Berne's Belpmoos airport on the morning of March 24th, 1959. Previously the helicopter had undergone a series of tests at Samedan airfield (5,610 ft. above sea level), with particular emphasis on climb performance. In the main, the performance figures published for the H-3 in* Interavia *No. 4, 1958 still hold good, though certain improvements have since been made in the power and consumption of the ramjets at the tips of the two-blade rotor. The Berne demonstration was organized by Dr. Georg Hutmacher (Ultramar S.A., Société Financière, Zurich), who is Nederlandse Helicopter Industrie's representative in Switzerland.*

● **The Allison Division of General Motors** has announced that the first production conversion of a Convair 340 to Allison 501-D.13 propeller-turbine engines and Aeroproducts 606 propellers has begun. The aircraft was recently purchased from Hawaiian Airlines. Actual conversion work is being done by Pac Aero Engineering Corporation, Santa Monica, California, under a sub-contract arrangement in which Allison negotiates the direct sale with the customer. Fixed price for the conversion is $490,000, with the customer getting the benefit of any re-sale of engines and propellers from the original configuration. This price includes enlargement of the empennage and improved sound insulation plus nacelle modifications.

FAA certification of the modified Convair 340 is scheduled for October 1959. Allison points out that considerable flight test experience already has been established for the conversion through the Allison-powered YC-131C, which has been leased from the USAF; the YC-131C will be used for about 75 percent of the FAA certification flight testing programme. It is also disclosed that the first commercial aircraft converted to Allison propeller-turbines, the Convair 240 *Turbo-Liner*, has been sold to a private operator.

● **A JetStar prototype** will be converted by Lockheed at the end of this year to take four Pratt & Whitney J60 jet engines (JT-12) for test purposes. Production J60 engines will be available in October 1960, and the first production airframe of the *JetStar* will be completed in summer 1960. Lockheed hopes to be able to deliver the first production *JetStar* powered by four J60 jet engines at the end of January 1961 (to Continental Can Company).

● **Five Morane-Saulnier MS.760 Paris** twin-jet communications aircraft (powered by two Turboméca *Marboré IIs*) have been delivered to the French Air Force. Five more will shortly be handed over. The French Fleet Air Arm has taken delivery of its first MS. 760 which will be used for the testing of HF and VHF equipment at Saint Raphaël. To date thirty-six MS.760s have been exported to Argentina, England, Italy and Iran.

● **The Grumman Gulfstream** corporate transport aircraft has been provisionally certificated by the FAA to enable pilot-training and service/maintenance programmes to be carried out. The actual FAA test programme with the **Gulfstream** began two and a half months ago, and Grumman reports that over 200 flight hours have so far been logged with the first production *Gulfstream*. Both number two and three aircraft are also well along in flight test programmes. Grumman is turning out the *Gulfstream* at a minimum rate of three aircraft per month; assembly work on aircraft number 19 has begun, and the company expects to have 27 aircraft in the air by the end of the year.

● **A second prototype of the Westland Westminster** flying crane helicopter is now under construction at the Westland works at Yeovil and is scheduled to fly this summer. Fuel tanks on this machine will be mounted externally.

● **The U.S. Air Force** recently fired the 100th Aerojet *Aerobee-Hi* high-altitude research rocket from the firing base at Holloman AFB, New Mexico. To date Aerojet has produced more than 200 *Aerobee* rockets for the USAF, Navy, Army and other agencies.

● **The SE.210 Caravelle,** which has been undergoing a series of aging tests at Etablissement Aéronautique de Toulouse, had completed 10,000 simulated flights by March 28th, 1959. Each of these flights represented an average flying time of three hours, so that the test airframe has logged a "total flying time" of 30,000 hours at Toulouse. The tests have been carried out without incidents, and are continuing according to schedule.

From the results published following the conclusion of static load tests, it emerged that the gross weight of the production *Caravelle* has been increased to 95,900 lb. In addition, the progressive increase in engine thrust from the present 10,400 lb. to 11,400 lb. in 1960, and to 13,000 lb. for the version to be fitted from 1961 onwards, will make it possible to raise cruising speed at 32,800 ft. to 430 knots. Ultimately the *Caravelle's* gross weight is scheduled to reach 99,210 lb.

McDonnell 119 four-jet multi-purpose and VIP transport. For the first phase of flight testing it is fitted with down-rated Westinghouse J34 jets, but will later have Pratt & Whitney J60 (JT-12) engines of 3,000 lb. thrust each.

Strip or dial? — It's the height that really counts!

By Albatross, London

A flight of United States Air Force F-86D *Sabre* jet fighters returned from a scramble last October, broke formation and lined up for a stream GCA-GCI let-down to their West German airfield. It was raining at the time, and visibility on the runway was about 1,400 yards beneath a cloud base of 800 feet.

The three aircraft landed all right, but only the alertness of a radar operator saved one of them from sounding a tragic finale to the mission.

When the first of the trio to be worked failed to appear on the precision radar and was waved off with instructions to stand by at 2,700 feet while the remaining two fighters were talked down through the overcast, the radar operator acted on a hunch that the altimeter in the waved-off aircraft was not functioning properly or that it was being misread. He got GCA to tell the pilot to re-check his reading and asked GCI to ascertain the aircraft's height.

The pilot replied that he was maintaining 2,700 feet as instructed, GCI that he was some 10,000 feet higher. Need more be said ?

In America a USAF plane hit a hill when it was supposed to be holding at 16,000 feet. When he repeated the reported holding patterns at 6,000 feet, an investigating pilot said he would have hit the hill ten yards from the crash site had he not pulled up.

Accidents of this kind should never happen, but they do, and they beg the question, " How can we stop them ? "

*

Until we started pressurising aeroplanes and operating at heights in excess of 10,000-feet, the standard three-needle altimeter (Fig. 1) did a good job. It was not often that a pilot cruised above 8,000 feet, and if he did he was so conscious of the fact that it was scarcely possible for him to make an error.

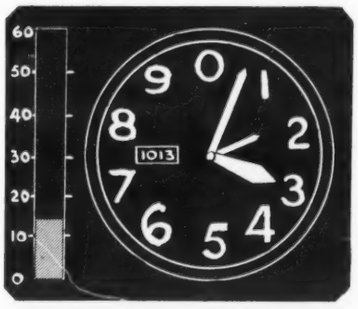
As aircraft climbed higher, however, that afterthought of a needle, the 10,000-feet pointer, lost itself more and more frequently behind its bigger brothers, which casually swept round the altimeter clock-face checking off hundreds and thousands of feet, with the result that an increasing number of pilots misread their altimeters.

Fig. 1: This standard three-pointer altimeter (Kollsman), set for a sea level pressure of 29.92 inches of mercury (equal to 1,013 millibars), shows an altitude of 16,090 ft.

Fig. 2: Older model counter altimeter (Kollsman) showing the same altitude of 16,090 ft. for the same sea level pressure.

Fig. 3: New British altimeter (Kelvin & Hughes) with funnel-shaped 10,000-ft. needle plus " tail " and warning flag for altitudes below 15,000 ft., set to 1,013 millibars.

Fig. 4: Normal three-pointer instrument for indicating altitude, and the author's proposed parallel strip altimeter with Dayglo band to show ten thousands of feet. The strip altimeter could be connected to a separate pressure source to provide a cross check.



Accidents followed, and it soon became abundantly clear that it was not pilot error which was causing them, but a hazard inherent in an instrument created for a bygone age.

In considering what had to be done, however, those responsible lost sight of the urgency with which it was necessary to provide a solution and went off to dream up ideal instruments for the distant future—instruments that would take years and plenty of money to develop, like the vertical strip, the counter (Fig. 2) and the drum altimeters.

Then crash, bang ! The pilot of a BEA *Viscount* read 14,500 feet for 4,500 feet last April, and a few minutes later crashed near Prestwick. Luckily he survived (there were no passengers aboard) to become the centre of a controversy in Parliament which is raging yet.

Not so lucky was the captain of the BOAC *Britannia* which finished its Christmas Eve test flight as a smouldering heap in a woodland a few miles north of Bournemouth for the same reason. He was killed.

There have been many incidents, but these two really rammed home the need to do something—and fast.

*

The results—in Britain, that is—were some inspired suggestions, and it is to *Captain Starling*, BEA's Flight Manager, Renfrew (Glasgow), that credit must go for the idea of using on the ordinary three-pointer instrument, a disc under the main face, keyed to the 10,000-feet pointer to show a segment growing with height.

Fig. 5: Highly sensitive vertical strip altimeter (Bulova Research & Development Laboratories).

Developed by *Kelvin and Hughes* and now on order for all BOAC and BEA aeroplanes, this altimeter (Fig. 3) has two windows in the dial. The one on the left displays a chequered flag below 15,000 feet, and this display increases as altitude decreases below this figure. The window on the right opens up as height is increased to display a tail to the 10,000-feet pointer, which lies around the circumference of the dial, from zero to wherever the 10,000-feet needle may be.

Now although this new method of displaying altitude information dispels the possibility of ambiguity, many pilots are far from satisfied that it will safeguard them from over or under-reading altitudes by 10,000 feet.

To meet this criticism it has been suggested that the segment exposed as height increases should be treated with red " Dayglo " luminescent paint, or that a vertical reading altimeter with a tape treated in the same way or with two striking colours, should be set beside a normal altimeter as a simple checking device (Fig. 4).

Normal colour coding has been thrown out as a means of identifying different heights largely because experience has shown differentiation at night to be extremely difficult, particularly if the effect with various combinations of ultra-violet, red and white lighting has to be considered. Colour values are particularly critical in red lighting for example. And yet, according to some privately conducted tests, " Dayglo " does not seem to be similarly affected.

But it is nearly always the simplest compromise which proves to be the most effective in the absence of the ideal, and BEA is today examining two of the most elementary safeguards to crossing the 10,000 ft. level inadvertently, with a view to fitting one of them to its fleet.

The first is a light that comes on as soon as an aircraft on the descent reaches 10,000 feet. The second is simply the installation of an elementary, single-needle " Tiger Moth " altimeter as a stand-by check instrument.

What, though, is the ideal altimeter ?

There are two schools of thought on the answer; the first which backs the counter and needle instrument, and the second which supports the vertical strip or thermometer type of presentation.

On the face of it the strip instrument (cf. *Fig. 5*) appears to be the more logical of the two, and great hopes were placed on it since it had been chosen for the English Electric *Lightning* fighter. But the RAF threw it out with the remaining ribbon instruments Kelvin and Hughes had developed for the aircraft, and reverted to a clock-faced layout.

The reason is simple enough: pilots don't like the strip. And it is not because they are accustomed to the dial and refuse to make the change, but because, sensitive though a strip can be made, it does not alter its appearance dramatically enough to obviate the need to read it consciously instead of assimilating the information at a glance.

In other words, a pilot responds more readily to the lively sweep of a needle than to the restricted up and down movements of a vertical scale. This is particularly true of heavy pressure flying under control in the vicinity of airfields.

In a phrase: *The needle keeps the senses sharper!*

The ultimate answer to unambiguous height presentation within the compass of present knowledge and experience, therefore, seems to lie in the electrically servoed counter instrument or its close cousin, the capsule-driven drum altimeter. On both these instruments altitude in thousands of feet is read in digits through a window on the dial, and hundreds from a single needle sweeping a set of conventional figures.

Having been designed and put to the test some years ago, why is it these instruments have not been made standard equipment for all aircraft ?

In the first place uncertainty still exists as to whether the electrically servoed altimeter has been tried out sufficiently to be foolproof ... together with a marked distrust in electrics. Doubts about the drum instrument have also been expressed on the grounds that the capsule configuration has been taken more or less to its limits. The capsule's power is sufficient only to drive a set of needles round a dial. To try to make it do more, some people assert, is to court inaccuracy of reading at high altitude.

*

Whatever arguments there may be in theory regarding the different types of presentation, however, there is no doubt that only practical experience can show where any particular type of presentation can lead to doubts. Many pilots believe the present three-needle system leads to no ambiguities provided the pilot sticks to his drill and observes first of all the 10,000-feet needle which gives him an approximation of his height, which can then be made more exact by reference to the 1,000-feet and 100-feet needles.

Be that as it may. For myself I am glad to see less ambiguous methods of presenting height information appearing on the instrument panels together with simple checking devices like lights and " Tiger Moth " altimeters—but wouldn't a change to the metric system make life very much easier, and safer ?

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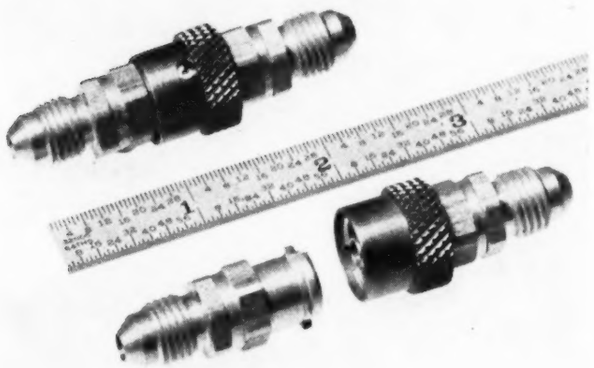
Recent Products of the Equipment Industry

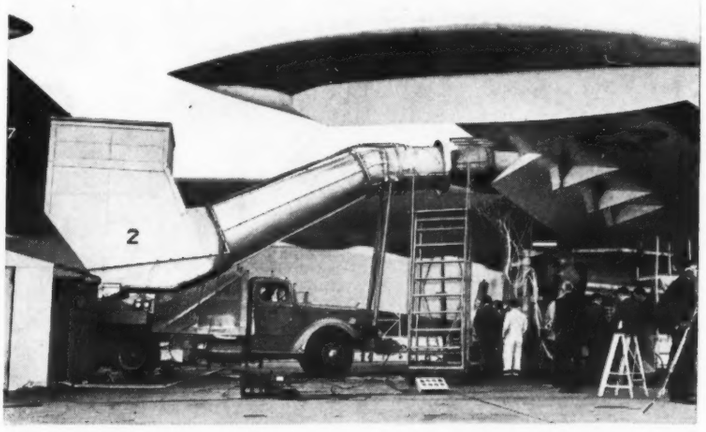
● **Minnesota Mining and Manufacturing Company,** St. Paul, Minnesota, is marketing a new material of high fluorescence for marking aircraft. Known as Fluorescent Scotchcal Film, the material can be easily applied in any pattern (e.g. stripes) on the wing, the tail surfaces, and on the top and bottom of the fuselage, etc., and can be easily stripped off intact. Scotchcal Film can be used on high-speed jet aircraft, but in this case the brushing of a liquid sealer along the leading edge of the film is also necessary to avoid the possible tearing off of the fluorescent strips at high speeds. Minnesota Mining finally announces that the useful life of the Scotchcal Film (after use under severe conditions) is around six months.

● Five U.S. airlines have placed orders for one hundred ground power vehicles with the Garrett Corporation's **AiResearch Manufacturing Division.** The vehicles perform ground support functions for the Boeing 707 and Lockheed " Electra ". The ground power unit provides pneumatic power for starting jet and turboprop airliners. In addition, the AiResearch gas turbine compressor (GTC 85-90) supplies compressed air for ground operation of turbine-driven vapour or air cycle regeneration equipment, ice and snow removal, cabin heating and ground check-out functions. Approximately half of the orders are for a second mobile model which combines a gas turbine compressor with a power unit. This provides pneumatic power plus shaft power for a 60 to 80 KVA alternator for checking radio, radar, hydraulic equipment, and operating the electric vapour cycling cooling and heating equipment. The gas turbine compressor starts and operates at −65° to 130°F. Recommended service life between overhauls is 1,000 hours or 3,000 starts. It is operated and controlled from the driver's seat. Picture shows the large side service doors. Fumes are exhausted through the top of the truck.



● Development of a new miniaturized coupling has been announced by **Aeroquip Corporation,** of Jackson, Michigan. Known as 1010 Series coupling, this equipment is 2.5 inches long and weighs slightly over one half ounce. It is suitable for electronic cooling systems, test stands, filling and charging connections, pressure sensing and other general aircraft or missile applications. Operating temperature range from −65° to +375°F with operating pressures up to 1,500 p.s.i.

● Engineers at the **Martin Company,** of Baltimore, Maryland, have developed a new portable jet engine noise suppressor (illustrated) for the Martin P6M " Sea-Master " four-jet flying boat, for use during ground run-ups. The new suppressors, which can be used with engines fitted with afterburners, work according to the noise conversion principle where the low-frequency roar of the jet engines is converted to a high-frequency, less audible, sound. The Martin unit and truck weigh a total of 38,000 lb. and measure 30 ft. in length. They were designed and built at a cost of approx. $50,000 each. Koppers Company Inc. will now build them under licence for the USAF, Navy, North American, Boeing and other companies.



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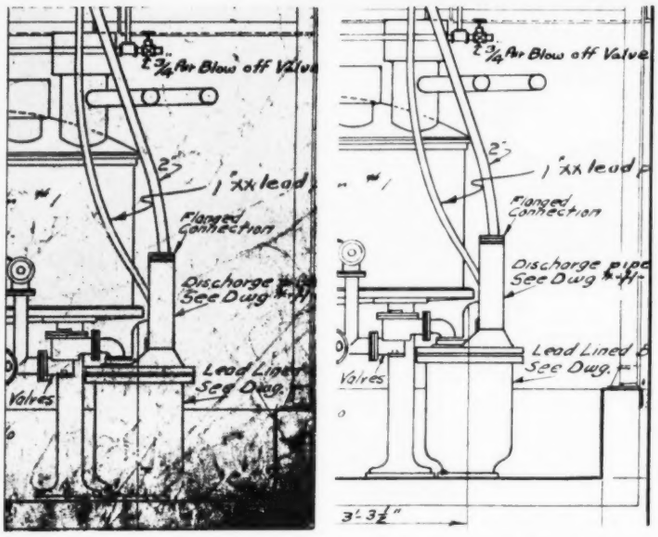

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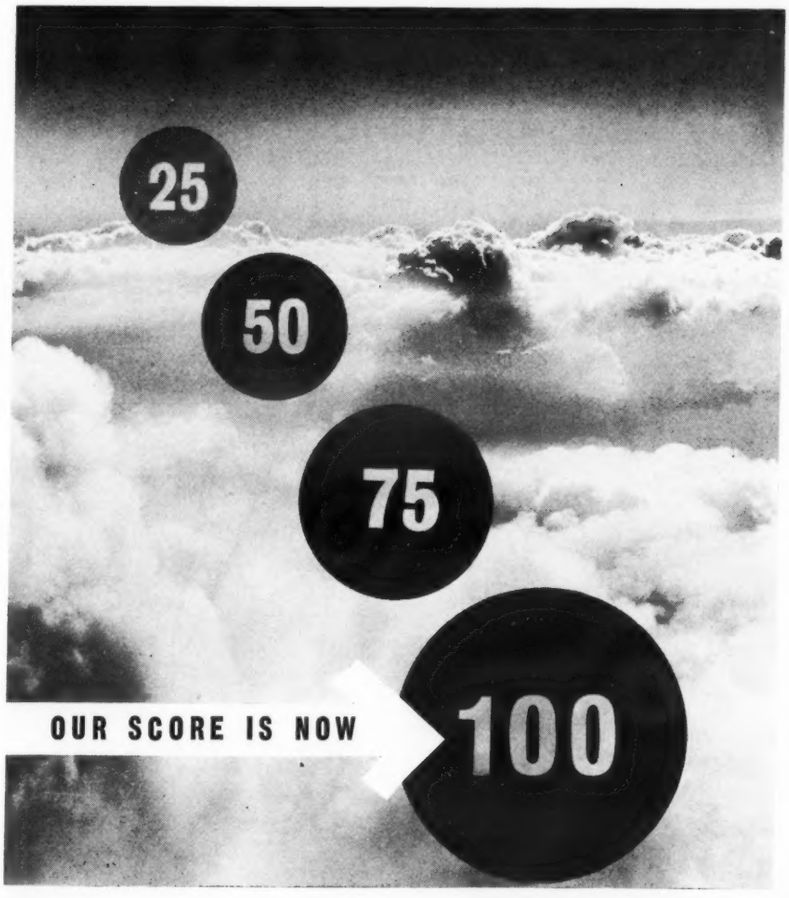

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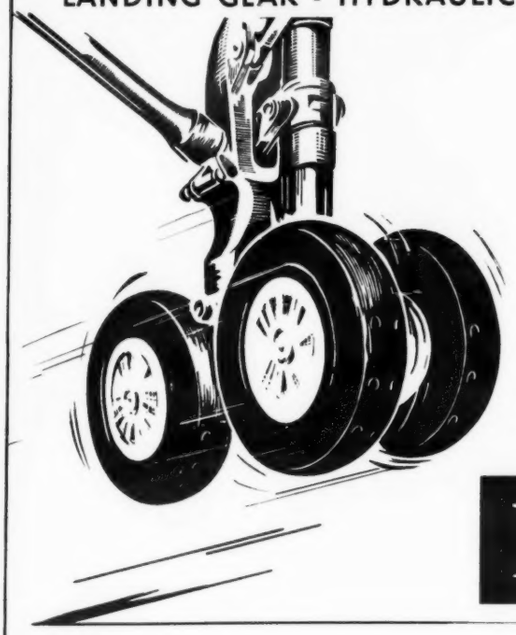

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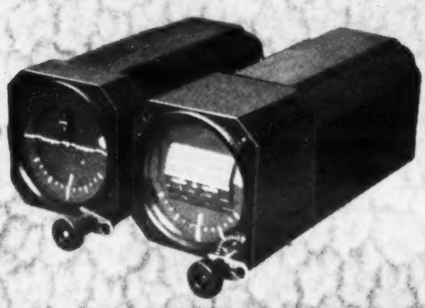

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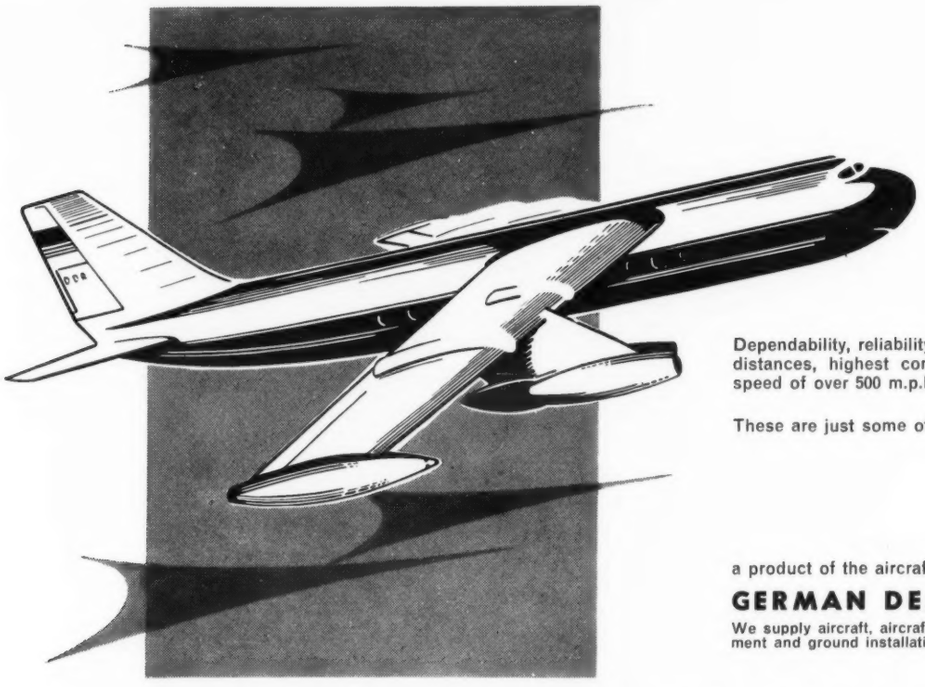

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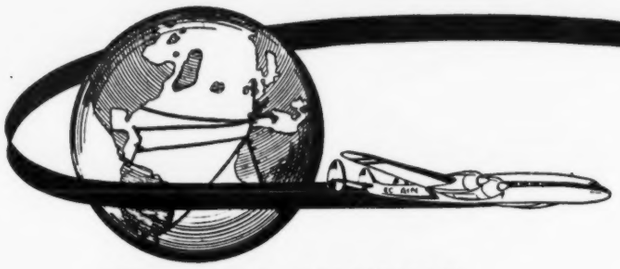

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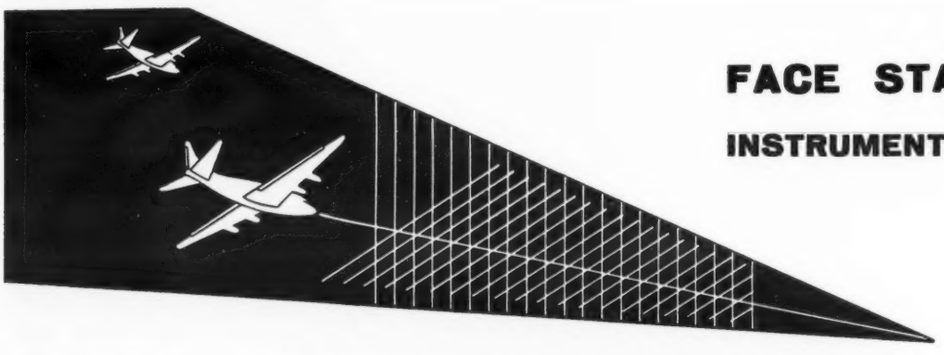

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